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With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

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Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

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THE TRUE STRUCTURE OF THE DIATOM VALVE.

By T. F. SMITH.

IT is not within the scope of this article to enter into the biological details of Diatoms, the writer assuming, and rightly too, he thinks, that they are already known to the readers of "KNOWLEDGE." His purpose is rather to treat of them as test objects; of the part they have already played in the development of the achromatic microscope; of the part they still should play in opening up the road towards further advancement. He also wishes to state his own views of the structure of the valve, the nature of which has given rise to so many discordant opinions.

FIGURE 1.
Upper layer.

In Ehrenberg's monumental work, "Die Infusionsthierchen," published in 1838, diatoms are treated as animals, in opposition to almost all the authorities of that day. This can be of but little importance to us now, save in showing how a great mind can be led astray by the following up of preconceived opinions. Of greater interest, so far as diatoms are concerned, are the superb coloured drawings giving us a clear insight of the definition of the microscope then. He describes the various species, some as smooth, some as striated; yet, on carefully going over the corresponding striated forms, under the microscope, it will be found that they can all be resolved by an inch objective of ·30 N.A.

While upon the subject of comparative capacity, it may be of interest also to give an example from a slightly later date. One species described and figured by Ehrenberg as smooth is *Navicula* (now *Pleurosigma*) *hippocampus*. In 1841, a Mr. Harrison, of Hull, discovered longitudinal striae upon this form, and sent specimens to the Microscopical Society of London, for confirmation. After keeping them for six months they were returned to him with the intimation that the members could see nothing. A little later he also discovered transverse striae on the same diatom valve, but found them more difficult to exhibit. These can be easily resolved now by a half-inch objective of ·50 N.A.

FIGURE 2.
Under layer.

Two layers of a valve of *Pleurosigma angulatum*. In each case entirely separated from the other and left sticking to the cover glass and to the slip respectively. Taken with a six millimetres objective, by Zeiss, ·95 N.A., and enlarged twice.

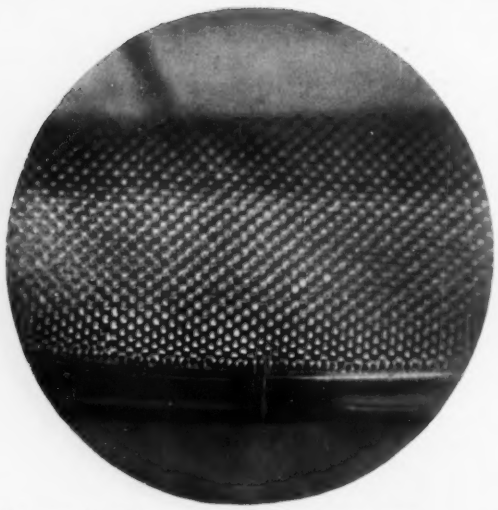

FIGURE 3. The outer side of *Pleurosigma formosum* when the valve is sound, × 1750.

When it was recognised that every increase of aperture in the objective revealed "markings" on forms deemed smooth before, there naturally arose from the students of diatoms a demand for more, and still more, light. It is customary with biologists to sneer at such as mere "diatom dotters," yet nearly all the optical improvements of the microscope have been due to their claims. Only by the consequent response of opticians could the science of bacteriology have become possible, which now plays so important a part in their (the biologists') own labours. From 1824 up to within the last twenty years there has been a regular progression of the powers of the objective, culminating in the apochromatic oil immersion. Unfortunately, at this point we seem to stick, though the cry is no less urgent for development.

The right interpretation of the "markings" turned mostly upon whether they were raised "beads" upon the surface, or holes through the substance of the valve. In the larger discoid and other forms it was admitted that the so-called cellules were excavations. Even here, however, Mr. Slack, in 1873, maintained that the hexagonal framework enclosing the cellules was made up of rows of beads. To the imagination of Mr. Slack, indeed, diatom structure began, continued and ended in beads.

The writer also must confess to a former belief in "beads." In a slide of *P. formosum* mounted in balsam were some isolated ones, even under the widest aperture of an oil immersion. Now, except one possesses the lively imagination of the Irishman, who explained the making of a cannon by saying "that they took a big long hole and poured molten metal around it," isolated perforations are unthinkable. One can only explain the puzzle by assuming that the structure around them, mounted in a medium of the same refractive index, was consequently invisible.

From analogy, the two or three layers of structure in the finer valves were merely assumed. It could scarcely be otherwise before the advent of the oil immersion. Rylands, in an article in *The Quarterly Journal of Microscopical Science* for October 1859, on "the markings of Diatomaceae," says of *P. angulatum*: "Individual specimens of this species are far from uncommon in which the outer 'aërolated' layer is partially removed, leaving the inner layer entire. Isolated portions of the outer layer may be found upon the valve, but I have never seen them separated, the force which removes them being apparently only sufficient to break them up into single 'aërolations'; the term in this case is unfortunate, for they are, in fact, hemispherical elevations."

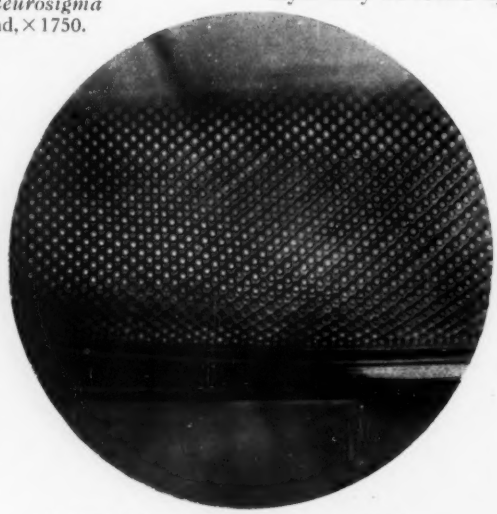

FIGURE 3 A. The same valve as seen in Figure 3, showing the structure immediately below that seen in Figure 3, × 1750.

Figures 1 and 2 prove that the valves of *P. angulatum* can separate entirely. It seems strange that to demonstrate this should be left to the present writer, nearly fifty years after the discovery of this form. The two pictures will well repay study with a single lens, magnifying some five or six times,

FIGURE 4. The inner side of *Pleurosigma formosum*. The ordinary appearance of a sound valve, × 1750.

when it will be seen how accurately the broken parts fit into each other. One layer was on the slip and the other tight against the cover glass.

He cannot claim to have been the first, then, to broach the subject of a second layer in the finer forms, yet he thinks he was the first to bring it within the borders of fact, by definition. The work presented here, except in the instances mentioned, was all done with the two millimetres apochromatic of Zeiss, of 1·40 N.A. Not that such an objective is necessary in order to see the structure figured, nor even to photograph the same. It can all be seen with an ordinary cheap oil immersion of 1·30. He has such a lens, of Swift and Son, costing only £5 5s., and it is astonishing to find how nearly it works up to the Zeiss, costing £20. This for the comfort of microscopists with only moderate means—by far the greater number. Every leading maker now produces a similar lens at about the same price.

The points desired to be driven home in the present article are that diatom structure consists of neither beads nor perforations, as commonly understood. The conventional presentment of the *Pleurosigma* every microscopist knows. The figures given here will differ from it in many particulars, as one would expect to follow from every increase of aperture in the micro-objective. A dry lens of any kind will always produce the same appearance from every unit of a particular species: the same can be said of an oil immersion when the valves are mounted in a medium, but when mounted dry, and an oil immersion used, it will be found that they

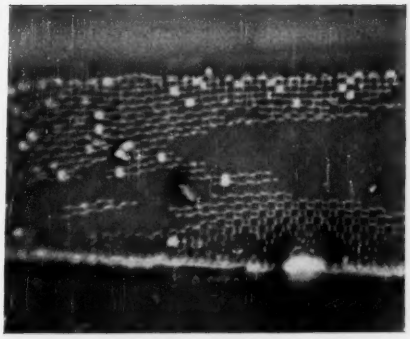

FIGURE 5. The outer side of *Pleurosigma formosum*, showing the structure torn and optically separated from that below, × 1750.

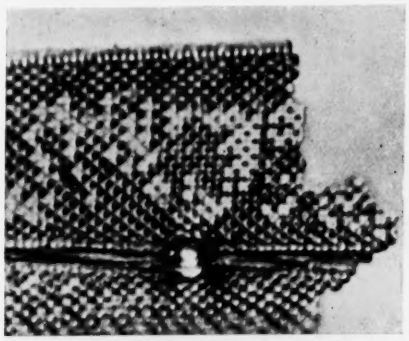

FIGURE 6. The same object as seen in Figure 5, taken with a dry six millimetres lens, by Zeiss; the upper structure is invisible owing to a too great depth of focus in the lens, × 720

FIGURE 7. The writer's "running down" case, × 1750, and further enlarged to 2500.

differ both visually and in curve. Figures 3, 3*a* and 4, from two valves of *P. formosum*, will illustrate this fact. Figure 3 shows the outer side of the valve, 3*a* the structure immediately underneath, and Figure 4 the inner side from another valve.

Now the difficulty attending upon the working of an oil immersion under these conditions, is that the object to be examined must be in optical contact with the cover glass. When against the slip, or even a little way off the cover, the lens is no longer at its fullest available aperture, indeed, it is but little better, if at all, than a dry glass. The same may be said when the object has more than one layer of structure, no matter how slightly they may be separated. There is the fatal film of air between to prevent that below being seen at its best. This is why nothing will be said here as to a third, intermediate, structure in the finer and thinner diatom valves. Analogy with the larger and thicker forms may seem to point in this direction, yet it has never been established by demonstration. Dr. Van Heurck asserts it in his more recent work, yet gives no figures as proofs.

It may be asked, why not examine the objects mounted in a medium? This, certainly, is by far the better way, when thick enough. On the other hand with very thin examples, upon removing one difficulty, one of another kind steps in, equally fatal. Though homogeneous, then, by lessening the angle of refraction, due to the medium, the depth of focus of the objective is increased, with the result that in such objects as a *Pleurosigma* valve, it pierces through all the layers, confusing the

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image of the whole. No increase of magnifying power will separate the layers, then, though one may know them to be there.

The real cause of failure may be explained in this way. Suppose a sheet of transparent paper with writing upon each leaf, differing, perhaps, in both character and subject. Clearly, if in close contact nothing could be read—separate the leaves to a proper distance, when both writing and meaning become plain. The *Pleurosigma* valve, mounted in a medium, is the sheet of transparent paper with the leaves together; mounted dry, the same sheet with the leaves well separated. Figures 5 and 6 will illustrate this point, though taken with different lenses. Figure 5 exhibits certain structure, discovered by the writer, upon the outer side of a valve, *P. formosum*, mounted dry, as seen under an oil immersion. Figure 6 is from the same valve, and the same point, taken with Zeiss' six millimetres aperture of ·95 N.A., a dry lens. The structure seen in the first print is here totally invisible as a recognisable image, though there are certain indications in some scattered dots, of which no one could discover the reason if taken by themselves, without the key. In both instances the magnification is the same.

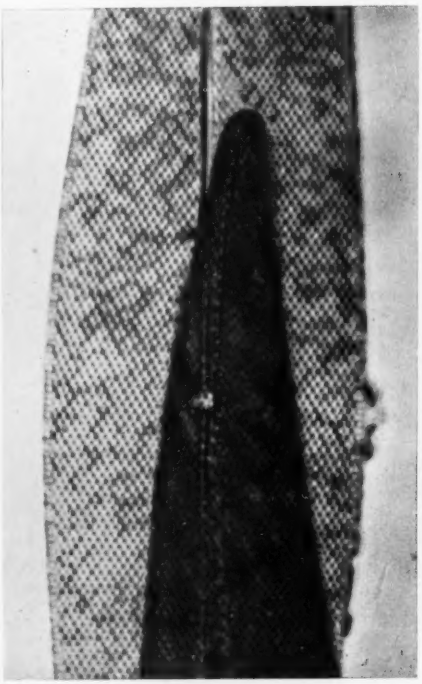


FIGURE 8. The same specimen as seen in Figure 7, × 1720, taken with the same lens and under the same conditions as Figure 6.

Figures 7 and 8 are further examples illustrating the same point. The subject is what the writer has called his "running down case." One minute diatom valve had collided with another and ripped up the deck, if one may be allowed to use such a term. In Figure 7 the torn structure at the sides is seen hanging in strips: so shallow is the focus of the oil immersion with which this was taken, that there are no indications of structure underneath, though of course in the microscope the fine adjustment would give it. It will be of interest to note here that the two valves present opposite sides to the eye. Figure 8 of the same incident is taken with the same dry lens as No. 6, but tells no story; not due to insufficient resolving power, as we shall see in another print, only that the objective has too deep a focus to separate the layers, or even the valves.

We are in this position, then: we cannot work with an oil immersion through successive layers of structure when there is air between—that is, not effectively — or separate them optically in a medium when the focus is too deep. This happens with all the species of diatoms given as examples here, except the last, and there seems to be only one other way.

We must examine spread slides in a dry mount, and note the difference in appearance and curves between the valves; study them separately then, remembering that, under an oil immersion, only those tight against the cover will give the distinctive image. Referring back to Figures 3 and 4, it will be seen that in Figure 3 only along the middle is it in sharp focus, shelving down on the upper side into shadow. Figure 6, however, shows the distinctive curve of the outside of the valve still better (though not the distinctive structure): on that side it is V-shaped in section. In Figure 4 of the same diatom, the inside, it is found to be flat across, except in the middle, where that and the median line are seen by the shadow to be below the general level. The same difference of curve between the two sides of the valve occurs also in *P. angulatum*, and seems always to accompany the same distinctive appearance.

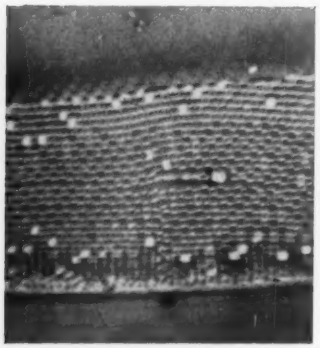


FIGURE 9. The outer side of *Pleurosigma formosum*, showing "chains" of fibrils giving rise to the appearances seen in Figure 3, × 1750.

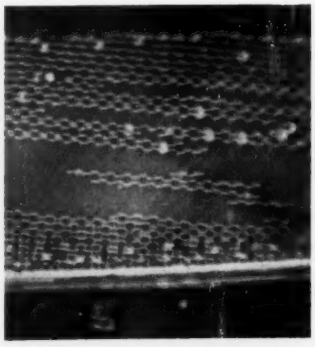


FIGURE 10. A similar specimen to that seen in Figure 9.

These details may seem trivial, yet are necessary in clearing the way towards getting at the key to the real structure. With regard to the outer side of *P. formosum*, Figure 9 seems to supply the key to Figure 3. The structure here is fairly sound, but in some way has been acted upon to leave it bare. It appears to consist of a series of chains, as it were,

formed of short bars or fibrils of silex, arranged lengthways on the valve. They run in pairs, parallel, each pair having larger and narrower interspaces between them in regular succession, and so placed that the larger interspaces are set obliquely to the corresponding interspaces between the other pairs, both above and below. Figure 10, from another valve, exhibits the same structure torn, and still more plainly because the "chains" are more isolated.

Now, in explanation of the figures, his theory is this, that what we see in the *Pleurosigma* valve, when sound, is not the structure at all, but simply a same valve mounted in a medium. The valve shown in Figure 11 has been ruptured, leaving in some parts the outer layer well separated from the under, in others normal. We see, then, at the lower part of the picture the characteristic structure; in the middle it is no longer visible, while at the top it re-appears, though not so well indicated. Figures 12 and 13 are taken by the oil immersion from the same spot, the first with the glass slightly stopped down, the second with the widest available aperture; leaving the image by itself, in the air as it were.

Now for all practical purposes Figure 12 is the

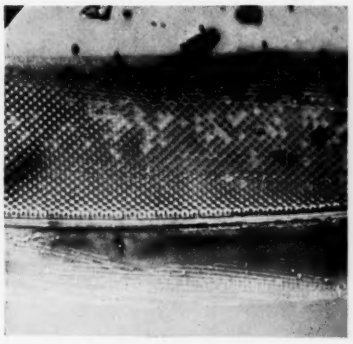


FIGURE 11. The outer torn structure of another valve taken with the same lens as Figures 6 and 8.*

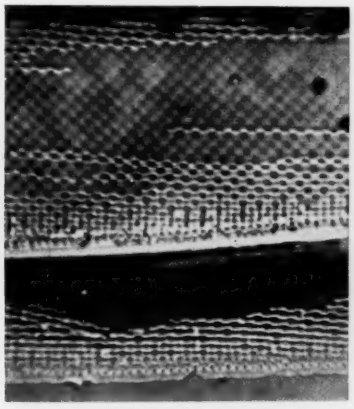


FIGURE 12. The same specimen as seen in Figure 11, taken with a two millimetres objective of Zeiss, slightly stopped down, × 1750.

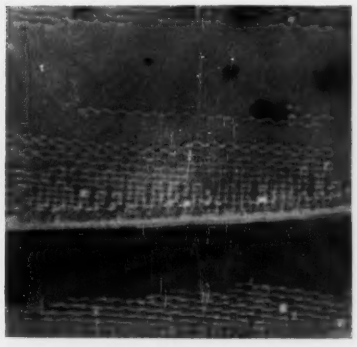


FIGURE 13. The same specimen as seen in Figures 11 and 12, taken with the fullest aperture available.

collection of focal images thrown from the other layer upon the one nearest the eye, just as a picture is thrown from the optical lantern upon a canvas screen. The fibrils or grating is the real structure, of which the texture is concealed, even as that of the canvas screen is by the picture. We shall see more of this further on.

The next three figures, taken from the outside of another valve, are given more to illustrate the value of aperture than to elucidate structure. Figure 11, photographed by the same dry lens as Nos. 6 and 8, shows that it was not from want of aperture it failed to exhibit the right structure. To repeat, it is simply a matter of possessing too deep a focus to separate the component layers, though a most superb glass. No dry lens could do it when at the normal distance apart, nor even an oil immersion, with the most effective picture, as affording opportunity for comparing the relationship of the two layers; yet it is always well not to give the enemy cause to blaspheme. When these researches began, the results were put down by some to moisture in the dry mount, to oblique light, to interference phenomena; to every cause, in fact, except to a revelation of new structure. Speaking generally, perhaps the most irritating of all criticisms are those which, if they are valid, will not only deprive one of all claims to be looked upon as an accurate observer, but also of common sense in conducting his researches. Naturally, in very self-defence, one was put upon his metal, and, by widening the aperture to the fullest available, produced photographs of which this last print and others are examples.

(To be continued.)

* Here the outer structure is only seen where it has been left against a cover glass more than the normal distance from the under layer.

THE FACE OF THE SKY FOR AUGUST.

By W. SHACKLETON, F.R.A.S., A.R.C.Sc.

THE SUN.—On the 1st the Sun rises at 4.24 and sets at 7.48; on the 31st he rises at 5.11 and sets at 6.51. Sun spots are not very numerous; small groups are occasionally visible on the solar disc.

The positions of the Sun's axis, centre of the disc, and heliographic longitude of the centre are given in the following table:—

Date.	Axis inclined from N. point.	Centre of Disc N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Aug. 4	11° 52′E	6° 2′	335° 49′
,, 9 ...	13° 46′E	6° 21′	269° 42′
,, 14 ..	15° 34′E	6° 37′	203° 36′
,, 19 ...	17° 16′E	6° 51′	137° 31′
,, 24 ...	18° 49′E	7° 1′	71° 26′
,, 29 ...	20° 16′E	7° 9′	5° 23′
Sept 3 ...	21° 34′E	7° 14′	299° 20′
,, 8 ...	22° 44′E	7° 15′	233° 18′

THE MOON:—

Date.	Phases.	H. M.
Aug. 1 ...	☽ First Quarter	11 29 p.m.
,, 10 ...	○ Full Moon	2 55 a.m.
,, 17 ...	☾ Last Quarter	0 11 p.m.
,, 24 ...	● New Moon	4 14 a.m.
,, 31 ...	☽ First Quarter	4 21 p.m.
Sept. 8 ...	○ Full Moon	3 57 p.m.
Aug. 5 ...	Apogee	2 24 p.m.
,, 21 ...	Perigee	10 36 a.m.
Sept. 2 ...	Apogee	7 18 a.m.

OCCULTATIONS.—The following occultations of the brighter stars are visible from Greenwich:—

Date.	Star's Name	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. point. E.	Mean Time.	Angle from N. point. E.
Aug. 18	k Tauri ...	5·6	p.m. 11.11	95°	p.m. 11.57	235°
,, 22	λ Cancri ...	5·9	a.m. 2.13	95°	a.m. 3.3	277°
Sept. 1	43 Ophiuch ..	5·4	p.m. 7.58	182°	p.m. 8.4	191°

THE PLANETS.

MERCURY:—

Date.	Right Ascension.	Declination.
	h. m.	
July 31 ..	10 14	N 11° 19′
Aug. 10 ...	10 59	5° 8′
,, 20 ...	11 27	N 0° 15′
,, 30 ...	11 30	S 1° 28′
Sept. 9 ...	11 3	N 2° 14′

Mercury is an evening star setting N. of W. at 8.40 p.m. on the 1st, and nearly due W. on the 20th at 7.40 p.m. The planet is at greatest Easterly elongation of 27° 25′ on the 13th, when he sets at 8.7 p.m. The elongation is not a favourable one on account of the low declination of the planet.

VENUS:—

Date.	Right Ascension.	Declination.
	h. m.	
July 31 ...	11 20	N 2° 18′
Aug. 10 ..	11 39	S 1° 32′
,, 20 ...	11 48	4° 34′
,, 30 ...	11 45	6° 14′
Sept. 9 ...	11 28	S 5° 53′

Venus continues to be a very conspicuous object in the evening sky, looking S. of W. immediately after sunset. The planet is at "greatest brilliancy" on August 10th, when 0·26 of the disc is illuminated and the apparent diameter is 38″.

As seen in the telescope the planet appears crescent, like the new moon, three or four days old, and on account of the large apparent diameter, the crescent form is easy to see, even in small telescopes magnifying about ten times.

Venus is a severe test for most telescopes, but observations are somewhat easier if they are made whilst it is still broad daylight. On the 1st, the planet is on the meridian at 2.45 p.m. and sets at 8.55 p.m.; on the 20th the planet souths at 1.57 p.m., and sets at 7.38 p.m. During the past month, many persons have been able to see Venus as early as 3 p.m. with the naked eye, but there is little difficulty in picking up the planet half-an-hour before sunset. Towards the end of the month the planet becomes unobservable, as she sets too soon after the Sun.

MARS:—

Date.	Right Ascension.	Declination.
	h. m.	
July 31 ...	2 34	N 12° 53′
Aug. 10 ...	2 58	14° 44′
,, 20 ...	3 20	16° 20′
,, 30 ...	3 41	17° 42′
Sept 9 ..	4 0	N 18° 49′

Mars rises in the E.N.E. at 10.45 p.m. on the 1st, and at 9.30 p.m on the 31st. At the beginning of the month the planet is about 1° South of σ Arietis, and at the end of the month about 5° South of the Pleiades. The apparent diameter of the disc is only 10″, and the planet is not very bright or well suited for observation in small telescopes.

The summer solstice of the Southern hemisphere of the planet occurs on August 1st, and since it is the South polar cap that is visible from the earth, we may expect that the snow cap will not be very conspicuous when the planet is in a favourable position for observation at the opposition in November.

The planet is in quadrature on the 9th.

JUPITER:—

Date.	Right Ascension.	Declination.
	h. m.	
July 31 ...	14 16	S 12° 29′
Aug. 10 ...	14 19	12° 50′
,, 20 ...	14 24	13° 15′
,, 30 ...	14 29	13° 44′
Sept. 9 ...	14 35	S 14° 15′

Jupiter is getting more to the West, but still remains a conspicuous object in the evening sky, and is available for

observation for a few hours after sunset, as he sets W.S.W. at 9.28 p.m. on the 20th. On account of increased distance from the earth, the apparent diameter is diminishing, the equatorial diameter on the 20th being 34″, whilst the polar diameter is 2″·2 smaller.

The Moon appears near the planet on the evenings of the 1st and 29th.

Only few satellite phenomena are observable on account of Jupiter appearing in a bright part of the sky; these are as follows:—

Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.
Aug. 2	I.	Sh. E.	9 14	Aug. 9	I.	Sh. I.	8 57	Aug. 11	III.	Sh. E.	7 37
5	II.	Ec. R.	8 35	10	I.	Ec. R.	8 15	18	I.	Sh. E.	7 33

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its reappearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress; "Ec. D." denotes disappearance of Satellite by Eclipse, and "Ec. R." its reappearance.

The configurations of the Satellites as seen in an inverting telescope, and observing at 8.30 p.m. are as follows:—

Day.	West.	East.	Day.	West.	East.
1	$\frac{2}{4}$ ○	3 ●1	17	○	423 ●1
2	41 ○	23	18	2413 ○	
3	4 ⊙	13	19	432 ○	1
4	$42\frac{1}{3}$ ○		20	431 ○	2
5	43 ○	1 ●2	21	432 ○	1
6	431 ○	2	22	421 ○	3
7	423 ○	1	23	4 ○	123
8	421 ○	3	24	41 ○	23
9	⊙	423	25	241 ○	3
10	○	$\frac{1}{2}34$	26	32 ○	$\frac{4}{1}$
11	$2\frac{1}{3}$ ○	4	27	31 ○	24
12	3 ○	14 ●2	28	32 ○	14
13	31 ○	24	29	21 ○	34
14	$\frac{3}{2}$ ○	14	30	○	$\frac{2}{1}$ 34
15	21 ○	34	31	1 ○	234
16	○	1243			

The circle (○) represents Jupiter; ⊙ signifies that the Satellite is on the disc; ● signifies that the Satellite is behind the disc or in the shadow. The numbers are the numbers of the Satellites.

SATURN:—

Date.	Right Ascension.	Declination.
	h. m.	
Aug. 1 ...	3 10	N 15° 21′
,, 16 ...	3 13	15° 28′
Sept. 1 ...	3 14	N 15° 29′

Saturn rises on the 1st at 11.5 p.m. and on the 31st at 9.15 p.m.; each week he becomes more favourably placed for observation. Towards the end of the month the planet may be observed looking North of East at 10 p.m. a few degrees above the horizon; he appears as a bright star shining with a leaden hue. The telescopic view of the planet is extremely fine on account of the ring encircling the planet, and a good view may be obtained in small telescopes of about two inches aperture, if the object glass is good and the instrument is held steady. A magnifying power of about fifty is sufficient to show the ring, but a greater magnification is required to see the belts on the disc, as they are not so conspicuous as those on Jupiter. The ring appears well open, the plane of the ring being inclined to our line of vision at an angle of 22°; the southern surface is visible. The diameters of the outer major and minor axes of the outer ring are 43″ and 16″ respectively, whilst the polar diameter of the ball is 17″. The planet is stationary on September 3rd, after which his motion is retrograde or westerly The planet is in quadrature on the 13th. The Moon appears near the planet on the morning of the 17th.

URANUS:—

Date.	Right Ascension.	Declination.
	h. m. s.	
Aug. 1 ...	19 56 21	S 21° 20′ 15″
Sept. 1 ...	19 51 55	S 21° 32′ 0″

Uranus though somewhat low down in the sky, is well placed for observation during the early evening, the planet being due South on the 15th at 10.21 p.m. He is situated about 2° S.E. of σ Capricorni. Uranus is just perceptible to the naked eye, but can easily be seen with a pair of opera glasses. The diameter of the disc is nearly 4″, and the colour is greenish. As seen in large telescopes the planet appears more luminous at the centre of the disc than at the limb—somewhat similar to Jupiter and Saturn. The planet has a fine spectrum containing broad dark bands.

NEPTUNE:—

Date.	Right Ascension.	Declination.
	h. m. s.	
Aug. 1 ...	7 34 23	N 21° 6′ 2″
Sept. 1 ...	7 38 40	N 20° 56′ 10″

Neptune does not rise till 3 a.m. on the 1st August and 1 a.m. on September 1st; thus for all practical purposes the planet is unobservable.

METEORS:—

Date.	Radiant. R.A.	Radiant. Dec.	—
	h. m.		
Aug. 10-12...	3 0	N. 57°	Great *Perseid* shower; radiant moving E.N.E. about 1° per day.
,, 15-25...	19 24	N. 60°	o Draconids; bright slow meteors.

The *Perseid* shower lasts nearly all the month, the earth encountering the densest portion of the swarm about the 11th; the radiant then being near η Persei. The meteors are quick with yellowish streaks.

Minima of Algol occur on the 7th at 11.40 p.m., the 10th at 8.30 p.m., and the 30th at 10.20 p.m. The period is $2^d\ 20^h\ 49^m$., from which data other minima may be calculated.

TELESCOPIC OBJECTS:—

DOUBLE STARS.—Polaris, mags 2·1, 9·5; separation 18″·6. The visibility of the small star is used as a test for a good 2-inch object glass.

σ Scorpii, R.A. $16^h\ 15^m$; S. 25° 23′; mags. 3·0, 7·6; separation 20″·6.

ζ Sagittae, R.A. $19^h\ 45^m$; N. 18° 54′; mags. 5·7, 8.8; separation 9″·0; colours, white and blue.

α^1, α^2 Capricorni, R.A. $20^h\ 13^m$; S. 12° 50′; mags. α^1 4·5 α^2 3·8; naked eye double; separation 373″; very easy with opera glasses.

γ Delphini, R.A. $20^h\ 42^m$; N. 15° 46′; mags. 4·1, 5·0; separation 10″·8; very pretty double for small telescopes; colours, orange and light green.

NEBULA, &c.—Dumb Bell nebula in Vulpecula, nearly 4° due North of γ Sagittae. Rather faint object in a 3-inch telescope.

(M8) Cluster in Sagittarius; large luminous field of small stars; fine object in a pair of field glasses. About a degree E. of the star 4 Sagittarii.

XUM

NOTES OF A NATURALIST IN THE MEDITERRANEAN.

By G. B. HONY.

I PROPOSE in this article to give a brief outline of bird life noticed while on a four-months' cruise round the Mediterranean; particular attention being given to those birds which visit England as summer migrants. Little—far too little—is known of these birds in their winter haunts, and as I find that the dates at which I saw some of them in various places differ very considerably from those given in most books on the subject, they may be of interest.

I first saw swallows at Alexandria on March 5th. (J. E. Harting gives March 25th as the date of its re-appearance in Egypt, "Our Summer Migrants" page 179). At Cyprus they were common on March 14th. They arrived at Platea (S. Greece) in large numbers on April 1st, and when I finally left, a fortnight later, they were still there, but I saw no signs of nesting. One came on board on April 4th, when going up the Adriatic (42° 21′ N., 16° 30′ E., wind W.N.W.). At Malta they seemed common in the middle of the island on April 27th, though none appeared by Valetta. One came on board on May 1st (37° 18′ N., 10° 55′ E., wind N.W.) when going to Gibraltar. At the latter place they were common on May 6th.

Swifts were common at Cyprus on March 14th, and at Gibraltar on May 5th.

I saw a few House Martins at Venice on April 4th. One joined us when four miles from Malta, on April 19th, and there were quantities of them with the swallows at Malta, on April 27th. I did not actually see one at Gibraltar, but I expect there must have been some at the beginning of May.

There were some Sand Martins at Gibraltar on January 21st, this being the only time I saw any.

Hoopoes were common in Egypt at the beginning of March, at Cyprus on March 14th, and I saw one at Platea on March 23rd.

There was one pair of Ringed Plovers at Platea for about a week at the end of March, then they seemed to go.

Turtle Doves were numerous at Alexandria on March 3rd, and some of them seemed to be paired off by that date. One came on board on April 16th (36° 58′ N., 17° 50′ E., wind N.), when going from Platea to Malta. A pair boarded us on April 23rd, when about eight miles S.W. of Malta (wind N.E. by E.) One joined us on May 1st (37° 18′ N., 10° 55′ E.) when going from Malta to Gibraltar (wind N.W.).

Blackcaps and Whitethroats seemed common at Gibraltar on January 21st. At Malta the place was crowded with these and Wood Warblers, on April 25th. Blackcaps were again at Gibraltar on May 6th.

Pied Flycatchers and the allied species *Muscicapa albicollis* (the latter has a complete ring of white round its neck) were common at Malta on April 25th.

A Grey-headed Yellow Wagtail joined us on April 23rd, when about eight miles S.W. of Malta, but the main flocks arrived at Malta on April 25th, as did also the Meadow Pipits (wind W.N.W.) A Golden Oriole was caught at Malta on April 28th. I give the last facts on the authority of the bird catchers at Malta; these men had cages full of the birds mentioned and sold large numbers for a few pence each.

I also saw Meadow Pipits at Alexandria, on March 3rd, and on the same day I saw numbers of Spotted Flycatchers.

Black Redstarts were common at Gibraltar, on January 21st, and at Platea, on March 26th.

Of course the dates given above do not refer to the dates of arrival (except where so stated), but only to those on which I first saw the birds at such and such a place.

Amongst other interesting birds seen I may mention a pair of buff-backed Herons, which joined us when going from Platea to Malta, on April 16th. There was a strong wind from the North at the time; the birds seemed very tired and looked as though they wished to perch, but every time they got far enough up to windward they fell back and had to beat up again.

I never saw Blackbirds anywhere but at Gibraltar. Here they had a different note of alarm from the birds in England.

It is rather remarkable that whereas when we visited Malta in April it was full of birds, at the end of February I do not think I saw any birds except Sparrows, which by-the-bye are slightly different from English examples, being slighter and altogether more "gentlemanly" looking.

Flocks of Ravens were more or less tame in Cyprus, and when feeding on garbage would allow one to approach them much nearer than would rooks in England.

The flocks of Kites over Cairo are really wonderful. One day I counted sixty-five birds on the wing at once; a few may have been hooded crows (for at a great height it is hard to distinguish between them) but the majority were certainly Kites. At Platea I watched with some interest a pair of Common Buzzards. I found their nest on March 21st, when it had four eggs; they were not hatched when we left on April 13th.

Granada was crowded with Nightingales on March 10th. The people told me that they would all leave in a month's time, but I think that this opinion is only held because the birds stop singing.

XUM

THE NEW FAIRY FLY.

THE DISCOVERY OF THE FEMALE OF *MYMAR REGALIS*.

By FRED ENOCK, F.E.S., F.L.S., F.R.M.S.

In the course of my investigations into the life-histories of the British Mymaridae I have found it to be of the utmost importance and help to note the exact locality, not only of the ground, but the actual plant on which I have made a particular capture. I did so on June 3rd and 8th, bringing away some of the stem and leaves and placing them in a special breeding box. I scarcely need to say how frequently I scanned these stems with my magnifier in the hope of finding the royal partner of my new Mymar.* Day after day passed, without anything but tiny midges emerging. The longest day passed after a boisterous south-west wind—followed by cooler breezes—then on the 22nd, the Coronation day of King George V. and Queen Mary, when the grand procession had passed, down came the long-wished-for rain. Each day brought more rain, and Fairy Flies appreciate a gentle shower and moist atmosphere, which softens the hard stems through which the imprisoned Mymar has to bite its way.

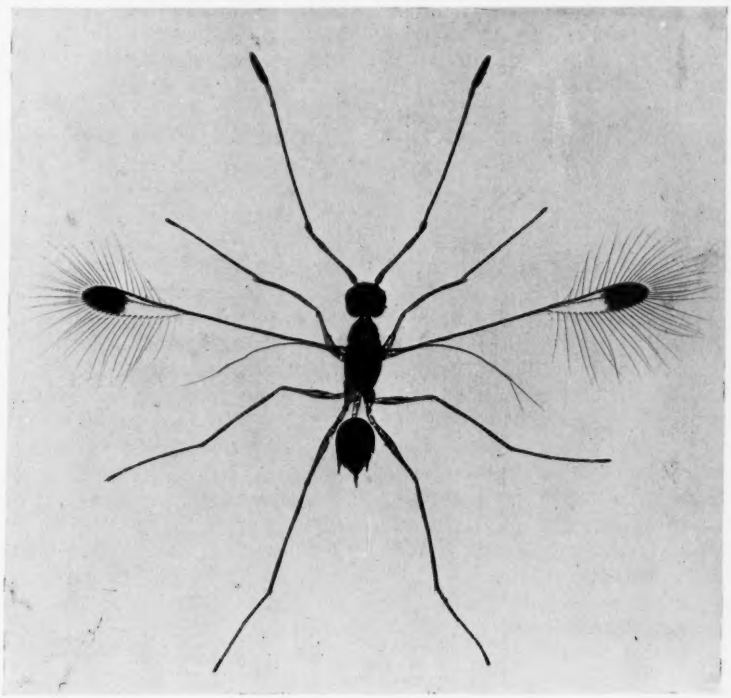


FIGURE 1.
Mymar regalis, magnified 30 diameters.

On June 27th, I carefully examined all my breeding boxes, finding a number of various species combing their antennae and preening their wings. At last I came to my special box, containing stems from Burnham Beeches, and there I saw a Mymar, which, when corked up in a tube, I tremblingly examined with my magnifier, and smiled with great happiness, for it was the royal consort—the female *Mymar regalis* with its under-wings arching down in a graceful curve, the tip terminating in a few long hairs.

The general colour of the body and legs is ferruginous, with a slight darkening on the dorsal area. The antennae are very delicate and as long as the whole insect, the first and second joint ferruginous, the third and fourth (the latter very long) dark brown, the fifth lighter, and the sixth, seventh and eighth almost yellow, while the ninth (the club) is dark brown.

After making a detailed description of it, I committed it to the killing phial, and it is now successfully mounted in that most beautiful of all media—Canada balsam. The capture of this most striking species, which is altogether new to the scientific world, proves that there are yet many good things to be taken if only there were more workers in the fascinating study of our Parasitic Hymenoptera.

During the past thirty-five years the writer has captured hundreds of specimens, composing eight new genera, running up and down the panes of glass of a small conservatory, as well as on those of the house.

* [In "KNOWLEDGE" for July, 1911 (Volume XXXIV, page 271), Mr. Enock described a new species of Fairy Fly under the name of *Mymar regalis* from a specimen of the male which he obtained in Burnham Beeches.—EDS.]

SOME NOTES ON *ACTINOSPHAERIUM EICHORNII.*

By EDMOND JOHN HUNT.

THE study of the minute organisms inhabiting pond and stream has ever proved a fascinating field of research to the student of that world of teeming life which the microscope has been instrumental in bringing within the range of man's vision.

Among the numerous forms of surpassing beauty shown by the microscope to be contained in a little water obtained from the weed-covered surface of some sequestered pool, few, perhaps, can surpass in general interest that veritable giant among its compeers—the *Actinosphaerium eichornii;* and the following brief notes, the result of close observation and study of that interesting organism, may possibly prove of some interest to many students of pond life.

Under the generic name, Actinophrys, Actinosphaerium was formerly ranked with the smaller Heliozoön—*Actinophrys sol*—but is now distinguished as *Actinosphaerium eichornii.*

Regarded as a microscopic organism, the *Actinosphaerium* is found to be of comparatively large dimensions; for, while the size of *Actinophrys sol* varies from $\frac{1}{430}$ to $\frac{1}{1200}$ of an inch, that of *Actinosphaerium* is about $\frac{1}{100}$ of an inch. Indeed, so relatively large is its size that, on holding to the light a small aquarium containing specimens of the organism, it may frequently be detected with the naked eye, appearing as a minute spherical speck of a greyish colour, either lying in the *débris* at the bottom of the bowl, or suspended among the threads of confervae which may be floating in the water.

Although holding a lowly position in the scale of life, the structure of the *Actinosphaerium* yet shows some advance on that of the *Amoeba*; the lobose extensions characteristic of the latter organism being in the case of *Actinosphaerium* differentiated into thin ray-like pseudopodia, which, although capable under certain conditions of being withdrawn within the body substance, are yet, as a rule, more often extended for the purposes of locomotion and the capture of food.

Placed on the stage of the microscope, under a lens of low power, the *Actinosphaerium* is seen, like the *Amoeba*, to consist of two layers, namely, an outer layer or ectoplasm, which is of a comparatively firm consistency, and an inner layer or endoplasm. Viewed under a lens of fairly high power, the ectoplasm is seen to be composed of a vacuolated substance, some of the vacuoles being of large size.

In appearance the ectoplasm somewhat resembles the meshes of a net, the lines representing the meshes containing minute dark coloured granules which are in constant motion, while the interspaces appear, as a rule, to be clear and colourless.

Treated with an alkaline reägent these vacuoles may be seen to coalesce.

In the endoplasm the vacuoles are of smaller size than in the ectoplasm; globules and granules of various kinds are present, and embedded in the protoplasmic mass may be seen numerous spherical bodies, each containing a dark-coloured substance. These bodies represent the nuclei with the accompanying nucleoli, and in some cases they appear to be present in very considerable numbers. As previously mentioned, the ray-like pseudopodia, radiating from the body in all directions, show a considerable advance in structure on those of the *Amoeba*, being apparently formed by an extension of the ectoplasm, while running down the centre of each pseudopodium is a structure having the appearance of a minute rod. These rods extend into the endoplasm, and in many cases appear to abut on the nuclei. Whatever may be the nature of the substance of which these rods are formed, and it does not seem to be at all clearly understood, there can be no doubt as to their being characterised by a remarkable condition of toughness and elasticity.

It sometimes happens that a free-swimming infusorian has the misfortune to be caught on the extreme end of one of the long pseudopodia, and, in its violent struggles to free itself, will bend the pseudopodium until the latter assumes the shape of a bent bow, having much the appearance of a fishing rod as seen in the hands of an angler playing a large fish. In such a case the strain must be enormous, and should the infusorian succeed in making its escape, a contingency which not unfrequently happens, the pseudopodium is seen to spring back at once to its original position, apparently quite uninjured by the severe struggle.

Under certain conditions, as, for instance, when transferred from one glass cell to another, the *Actinosphaerium* frequently completely withdraws its pseudopodia within the body substance, but they are soon again extended on the organism being left for a short time undisturbed.

The pseudopodia are used for the purpose of capturing food, and probably also as a means of locomotion.

In all the specimens under observation two and sometimes three contractile vacuoles were always present.

These vacuoles expand very slowly, and when fully dilated project beyond the surface of the body. The outer walls then contract, presumably casting out the fluid contents, although no passage through which these latter could escape can be detected.

In "The Microscope and its Revelations" Dr. Carpenter, in speaking of the contractile vesicle as seen in *Actinophrys sol*, says that "the cavity of this sacculus is not closed externally, but communicates with the surrounding medium, not, however, by any distinct and permanent orifice, the membraniform

wall giving way when the vesicle contracts, and then closing in again. This alternating action seems to serve a respiratory purpose, the water thus taken in and expelled being distributed through a system of channels and vacuoles excavated in the substance of the body, some of the vacuoles which are nearest the surface being observed to undergo distention when the vesicle contracts, and to empty themselves gradually as it refills."

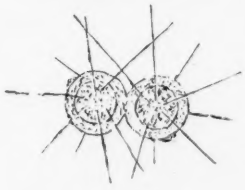


FIGURE 1.

When injured in any way the recuperative power of the *Actinosphaerium* appears to be very great. It sometimes happened that on transferring a specimen from the aquarium to the glass cell for purposes of examination the organism would sustain more or less damage, and on one occasion so great was the injury that a considerable portion of the endoplasm was pressed out of the body and could be seen floating in the surrounding medium, while the pseudopodia were all more or less destroyed. Despite, however, these apparently hopeless injuries, the work of repair was at once commenced and so quickly effected that in a comparatively short space of time the *Actinosphaerium* had made good the damage sustained, and with extended pseudopodia was ready to seize any prey that might happen to cross its path.

It is generally stated that when unsuitable conditions arise, the *Actinosphaerium* becomes encysted, remaining in this condition until the provision of a more favourable environment enables the organism to resume its normal state of existence.

No doubt this is sometimes the case, yet close observation points to the fact that under unsuitable conditions death often supervenes, while encystment more generally takes place prior to reproduction by division.

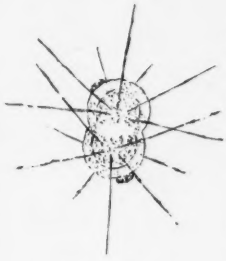


FIGURE 2.

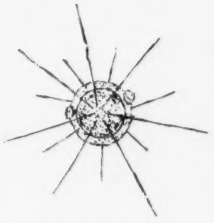


FIGURE 3.

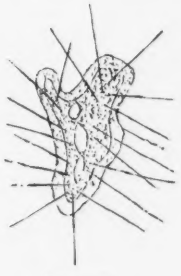


FIGURE 4.

Previous to death the endoplasm becomes greatly contracted and numbers of the pseudopodia appear to fuse, a process which gives them the appearance of broad spikes protruding from the body. After remaining in this condition for some time the contents of the body break through the containing membrane at some one point, filling the surrounding water with globules of various sizes.

A large portion of the life of the *Actinosphaerium* appears to be occupied with the capture of food, the choice ranging from small particles of vegetable matter to free-swimming infusorians, and even such comparatively highly organised and powerful creatures as the various species of Entomostraca. Of these latter the smaller species are easily captured, eaten, and digested, but with the larger species the *Actinosphaerium* does not appear powerful enough to deal.

The organism appeared also quite unable to cope with some Paramecia when placed in the same cell; the infusorians by a sudden twist of the body speedily freeing themselves from the clutches of the pseudopodia, which latter were invariably much damaged, and not unfrequently completely torn off in the struggle.

Periods occur when the *Actinosphaerium* rests from the labour involved in securing a sufficient food supply, and it is of great interest to note that during these intervals free-swimming infusorians appear able to come into contact with the pseudopodia with no danger ensuing to themselves.

When food-taking, the method adopted by the *Actinosphaerium* for capturing its prey is of peculiar interest.

Should an infusorian or other organism chance to come into contact with one of the pseudopodia, it is at once captured and firmly held; the capture being generally attributed to the action of a coating of some viscous substance. If this be really the correct solution, it seems clear that this substance can be secreted only during such time as the *Actinosphaerium* is engaged in food-taking; for, as previously mentioned, there certainly occur periods when similar organisms are able to come into contact with the pseudopodia with perfect impunity.

In the event of the captured organism proving to be of small size, it glides up the pseudopodium until, on reaching the body, a portion of the ectoplasm appears, as it were, to be rolled back, thus forming a kind of mouth within which the struggling victim is speedily engulfed.

When, however, an Entomostracan or other comparatively large organism happens to be caught, the mode of procedure adopted by the *Actinosphaerium* appears to be of a different character. In such a case the neighbouring pseudopodia are bent over to assist in holding the captured prey, while, by a process of contraction, the latter is slowly conveyed towards the body of the *Actinosphaerium*. After being engulfed, the Entomostracan or other organism is seen to be enclosed in a vacuole which soon commences a slow circulation round the body, a considerable time,

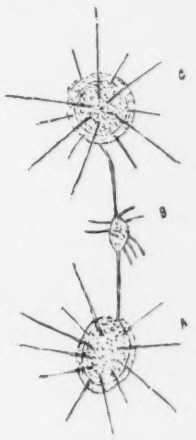


FIGURE 5.

however, elapsing before the struggles of the captured animal finally cease. In the case of an Entomostracan, the process of digestion being completed, the hard indigestible shell is gradually worked along to the surface of the body and ejected, a depression appearing in the ectoplasm at the place where the hard substance passed out into the surrounding medium.

The process of digestion is of a somewhat tardy nature; in one case an interval of nearly twenty-four hours elapsed from the time an Entomostracan was engulfed to the time the empty shell was expelled from the body.

Waste matter is occasionally ejected from the body of the *Actinosphaerium*. Sometimes this waste material is enclosed in a bladder-like vacuole which, on leaving the body, appears to glide along the pseudopodia, finally floating off into the surrounding water where it gradually collapses, the contents being dissipated. Occasionally these bladders are suddenly ruptured and the contents expelled with some considerable amount of violence.

Another curious phenomenon in the life history of the *Actinosphaerium* may occasionally be witnessed when two of these organisms slowly approach one another, cross their respective pseudopodia, and thus united, glide slowly through the water. In a short time the body substance of the two organisms may also be seen to come into contact, appearing as in Figure 1. After the lapse of about a quarter of an hour, the two bodies apparently become completely fused, as shown in Figure 2, their respective pseudopodia remaining, however, quite distinct, together with the two centres from which they radiate, while there appears to be a dividing line between the two endoplasms. This dividing line soon, however, disappears, the two endoplasms merge into one, while all the pseudopodia are now seen to radiate from a common centre, and in the course of about an hour the two bodies have become as one, as shown in Figure 3. The phenomena of cytotropy, or the mutual attraction of two or more cells, are in all probability closely connected with conjugation, and cytotropy, leading first to contiguity, may result in plastogomy, or the fusion of plasms. The protoplasm, however, must be in the proper plastic condition for such a union, and some of the Heliozoa are apparently always in this condition and contact results in fusion. In many cases, however, plastogomy leads to nothing further, and no nuclear fusion takes place.

Occasionally two large *Actinosphaeria* will unite and form a body as shown in Fig. 4, large spherical vacuoles being visible in the body substance. After remaining in this condition for some hours the two bodies gradually round off into the form of a perfect sphere. Again, it sometimes happens that the two bodies, after remaining fused for some hours, will separate, then appearing to be in the same condition as before the fusion occurred. In other cases, the two *Actinosphaeria* are seen to be united by a narrow band of protoplasm as shown in Fig. 5. In appearance this connecting band resembles an elongated pseudopodium, the only difference being that it is somewhat thicker, while in the centre thereof is an expansion having all the appearance of a very small *Actinosphaerium*. In a short time the band connecting the organisms A and B (Fig. 5) parts, leaving B, now rounded off into a perfect sphere, still attached to C. Soon afterwards the band connecting B and C is also severed, leaving B and C floating in the water as separate organisms.

It is possible that the above-mentioned phenomena form cases of plastogomy, and are not followed by fusion of the nuclei as in true cases of conjugation, although the latter has apparently been clearly established in *Actinophrys sol*.

The *Actinosphaerium* reproduces its kind by means of binary subdivision, which is repeatedly performed under the protection of a cyst.

In such a case the *Actinosphaerium* withdraws most of its pseudopodia, while others coalesce and protrude from the body in the form of broadish spikes. The ectoplasm appears to be very clear and the vacuoles of large size, while the endoplasm is dark and opaque, and the whole body shows a considerable decrease in size. In this condition it sinks to the bottom of the cell and, after an interval of some twelve hours, a kind of gelatinous substance commences to form around it. On touching this substance with the point of a very fine needle it is found to be of a slimy, sticky nature.

The gelatinous covering gradually increases in firmness, and under the protection thereof the body substance of the *Actinosphaerium* undergoes a process of division until from ten to thirteen different parts can be detected.

Each separate part is of a dark colour and is surrounded by an outer layer of some substance of a clear transparent nature. These various parts represent the young *Actinosphaeria*, which, after remaining in this condition for varying lengths of time, finally break through the cyst and soon acquire the likeness of the parent form. It has been stated that the *Actinosphaerium* reproduces itself by simple fission, the cell slowly separating into two parts, and it is further said that, should these organisms be kept for some time without food and then be provided with a superabundance thereof in the shape of Stentors, they will multiply rapidly by division.

However this may be, close observation of these organisms has never shown the *Actinosphaerium* to undergo division save under the protection of a cyst, while, furthermore, the introduction of Stentors into the glass cell invariably caused the *Actinosphaeria* under observation therein to withdraw their pseudopodia, being apparently quite unable to cope with the powerful Stentors.

THE COMMON SANDPIPER *(Totanus hypoleucus).*

Illustrated from Photographs

By E. W. TAYLOR.

A Common Sandpiper on her nest.

The eggs of the Common Sandpiper.

Young Sandpipers hatching.

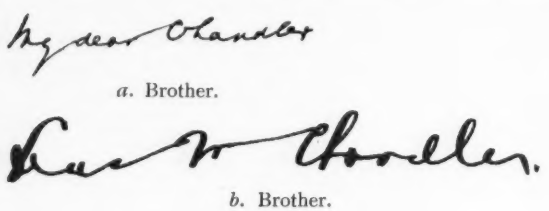
Young Sandpipers showing their protective colouring.

XUM

FAMILY HANDWRITING.

By R. H. CHANDLER.

THE likeness which exists between the writing of various members of the same family is often exceedingly strong, and for the purpose of a just comparison it is necessary to have the same words written by related people. The names and addresses on envelopes are very useful, though as these are written carefully when they are unknown, it would be better to have a few familiar words written without any hesitation. The family likeness in the illustrations which we give is apparent to anyone, and if we were not intimately acquainted with the handwriting of all of these it would be easy in some instances to mistake one for the other. Take Figure 3 (*a* and *b*), two brothers; Figure 4 (*a* and *b*), father and son; Figure 6 (*a* and *b*), two brothers; Figure 7, two sisters or Figure 9 (*a* and *b*) two brothers, which are hardly distinguishable one from the other; and even where the likeness does not approach almost to identity (as in the instances just given) there is a very strong family likeness in formation and style—take Figure 2, showing brother and sister where the style is pronounced and very similar, or Figure 3. Figure 5 shows the round handwriting of a father and son (if it were possible to show the signatures the likeness would be very much stronger) and Figure 9, which shows a strong likeness in the angularity (or acuteness) of the handwriting of three brothers.



a. Brother.

b. Brother.

FIGURE 1.

The words are joined in both cases and there is a great similarity in style.

Family likeness in handwriting follows the same general principles as family likeness among human beings, which may be defined as an accumulation of indescribably faint suggestions of similarity rather than any strong identity; for instance, a family likeness may show itself by the colour of the eyes (a very frequent one), shape of the nose, general outline of face, or eccentricity of manner, but more often it is the *tout ensemble* (something that we could not put into words and define accurately), which causes old friends of parents to exclaim, when meeting the children after some years,—"Isn't he like his father?" or, "He is just like his father as a boy."

This brings us to another point of agreement between handwriting and ourselves, viz., likeness at corresponding ages. It would be absurd to expect a grandfather of seventy to write like his son of forty-five, or his grandson of twenty, but there may be made a just comparison between the grandfather's writing at middle-age and his son's at the present time, or between that of the son and grandson at corresponding ages.

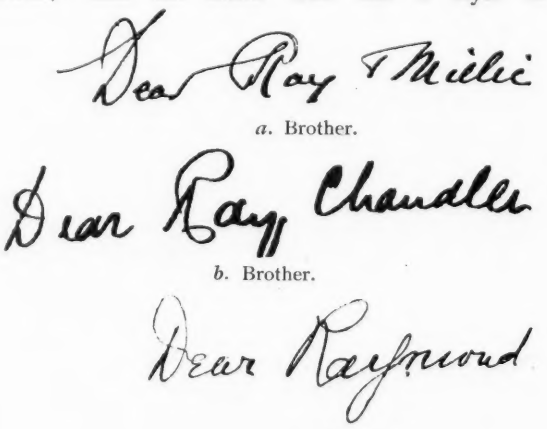
a. Sister.

b. Brother.

FIGURE 2.

The style of this handwriting should be compared with that of the three brothers, seen in Figure 3.

Another point of agreement (a sub-species of "family likeness") is what may be called "peculiarities," and the father who has a style of handwriting that shows these peculiarities will frequently bequeath them, more or less unaltered, to his son.



a. Brother.

b. Brother.

c. Brother.

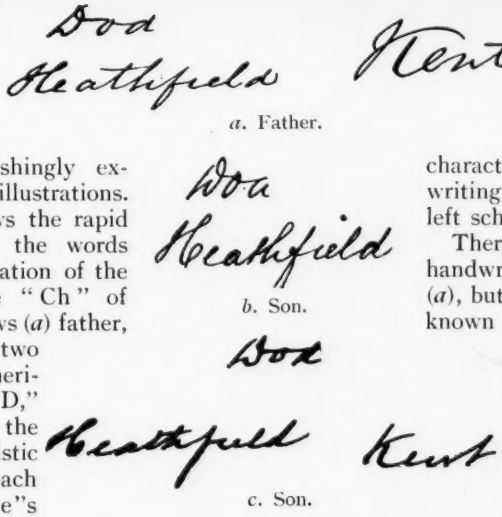
FIGURE 3.

a and *b* are hardly distinguishable.

Bearing in mind these suggestions, that is, the

influence of age on handwriting and the meaning of the expressions "family likeness" and "peculiarity," we may proceed to study some more examples.

Peculiarities are astonishingly exhibited in some of these illustrations. Take Figure 1, which shows the rapid writer's trick of running the words together; the peculiar formation of the "r" of "dear," and the "Ch" of "Chandler." Figure 4 shows (*a*) father, aged about seventy, and two sons, both of whom have inherited a peculiar capital "D," "H" and "K." In Figure 7 the writing is not a characteristic one, but the "the" in each case is identical and the "e"s are blind. But Figure 8 illustrates these features better; it is the handwriting of a father and son, and superficially one would say there was no likeness between them; but notice the capital "C"s and "B"s, the flourish at the end of "Chandler" in the father (*a*) has become a detached dash in the son (*b*); they both put "etc." or its equivalent after "Builder" (whose "e" is a Greek one in both cases) and they are liable to stop the pen at the same places—in the word "Chandler" they both leave a space after "h" and "n," in "Builder" after "l," and in "Belvedere" after "v" and "e." This last instance is very curious; for there is no apparent reason for leaving the "e" in the middle of the word all by itself when the four letters both preceding and following it are joined together.



a. Father.

b. Son.

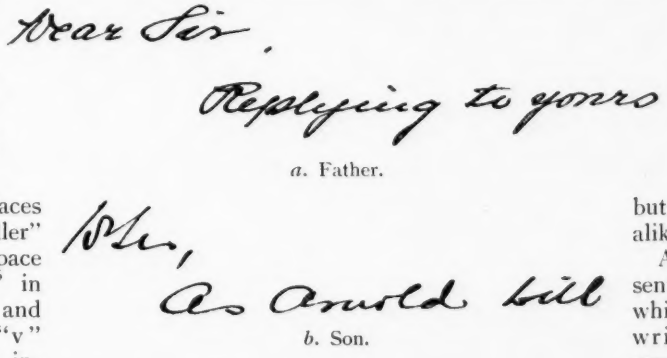
c. Son.

FIGURE 4.

The capital letters "D," "H" and "K" are peculiar, and there is a strong likeness between *a* and *b*.

I have been unable to collect such striking specimens of the handwriting of women as of men, and it may probably be taken as a general rule that women do not write such characteristic "hands" as men (the vast majority write very much less than men); besides, I fancy most girls on leaving school write a better (*i.e.* more formed and permanent) handwriting than boys at a corresponding age, which writing does not change so very much through life, whereas a boy usually does not begin to show his characteristic and permanent handwriting until some years after he has left school.

There is a common style of girl's handwriting (something like Figure 2 (*a*), but rounder and less characteristic) known as the "High School writing," I suppose, because High School girls write it, and if this does not alter later it shows that women write less characteristically than men; anyway, I have met with "High School girl's writing" in a woman of thirty, and I believe it would be rare to find a man whose handwriting had not altered between sixteen and thirty. These remarks apply to women who write a few family letters a week, and not to women in business, who might write as strong or as pronounced a style of handwriting as any man.



a. Father.

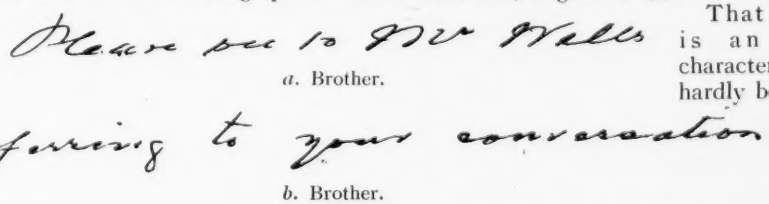
b. Son.

FIGURE 5.

The roundness of the writing in both cases is striking.

In Figure 2, there is not much to choose between brother and sister, and Figure 7 seems more or less weak and rambling, but this very weakness is alike in both.

A curious case is presented by Figure 4 (*a*) which shows strong handwriting for a man of seventy, and whose peculiarities are exhibited in (*b* & *c*) two of his sons, but his eldest son, Figure 5 (*a*), writes totally unlike the rest of the family, and yet he, Figure 5 (*a*), has bequeathed his own handwriting to his own eldest son, Figure 5 (*b*).



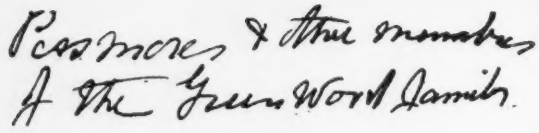
a. Brother.

b. Brother.

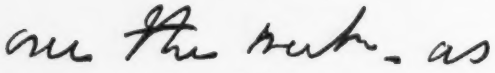
FIGURE 6.

The two handwritings are almost indistinguishable.

That handwriting is an acquired character there can hardly be any doubt. We only inherit the power of learning to write, though it would appear that the members of a family may inherit the power of writing in a particular way. There are, nevertheless, the questions



a. Sister.



b. Sister.

FIGURE 7.

The word "the" should be specially noticed and the handwriting in these two instances is also nearly identical.

of influence and imitation to be considered.

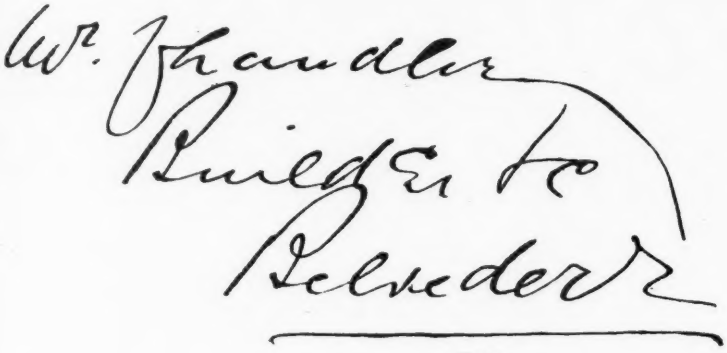
Charles Darwin, long ago, recognised that handwriting was inherited, and this idea may be found scattered through scientific literature as an axiom for the past fifty years, but, so far as I know, it has not been illustrated before.

A friend, to whom I mentioned these enquiries, informed me that he had frequently noticed that the juniors in an office came to write more like their chiefs as time went on, and I have since heard the same statement made by other people who had no interest in the subject, but as I am unable to produce any specimens it would not be well to rely upon this, which appears to be a clear case of environment and imitation (conscious or unconscious).

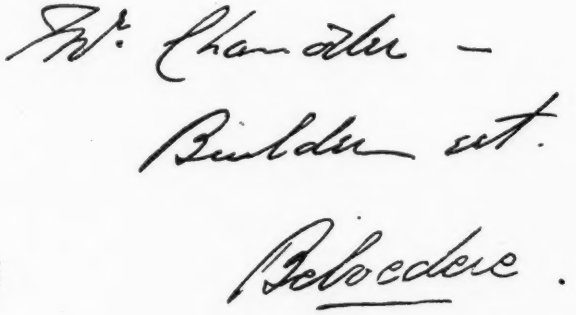
On the other hand, the writer of Figure 1 *a* lives in Wales and has probably not written my name more than two or three times in his life, whilst the producer of *b* has lived in London for the past twenty-five years and has written my name several thousand times.

In the case of Figure 3 the two brothers *a* and *c* were at school together, but *b* is fifteen years older and was educated entirely differently, yet the youngest brother *a* writes more like his eldest brother *b* than the middle one *c*.

Belonging to the family of Figure 4 there are two other brothers (besides Figure 5 mentioned above) whose writing is quite unlike these specimens and it seems more difficult to account for such differences than for many similarities.



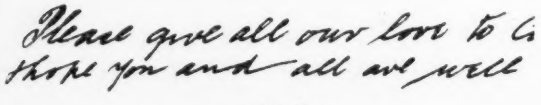
a. Father.



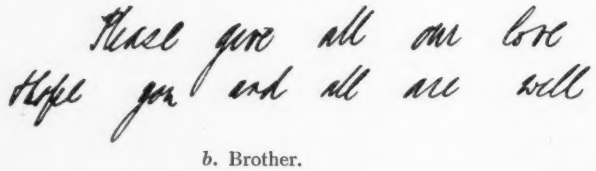
b. Son.

FIGURE 8.

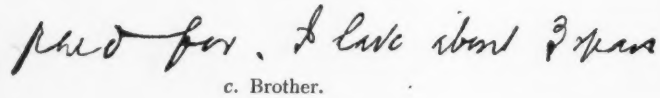
The capital "C's" and "B's" should be examined and the spaces left between some of the letters are also noteworthy.



a. Brother.



b. Brother.



c. Brother.

FIGURE 9.

All these specimens are angular, while *a* and *b* are very much alike.

These illustrations are sufficient to prove that handwriting is hereditary (sometimes to a remarkable extent), and in some instances environment can have had very little to do with it, but in many cases we know so little of the influences brought to bear upon such a flexible growth as handwriting, that it is quite possible to underestimate the effects of environment.

A UNIQUE SUNDIAL.

By O. PAUL MONCKTON.

SINCE the days of Ahab, King of Israel, the art of dialling has been practised by kings and princes as well as by less favoured folk; but although many quaint dials are known to be in existence, the writer quite recently came across a specimen which must be unique in the annals of horology.

This dial, of which a full-size drawing will be seen in Figure 1, 2, and 3, consists of a short cylindrical body, made of wood two-and-a-half inches long by three-quarters of an inch in diameter, surmounted by a wooden conical cap one-and-a-half inches long by three-quarters of an inch in diameter at its thickest section. This cap fits into the top of the cylinder, the latter being made hollow for the purpose.

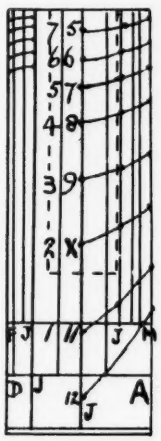


FIGURE 1.

The cylinder. The dotted line shows the hollowed recess.

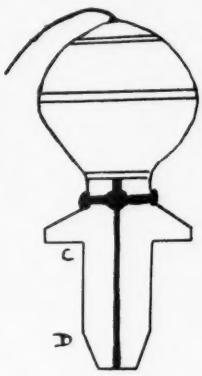


FIGURE 2.

The cylinder cap with the gnomon lying in the saw cut.

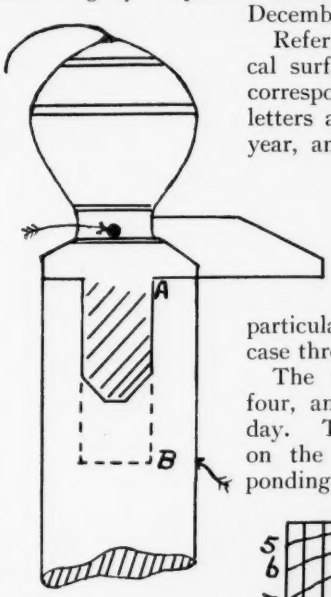


FIGURE 3.

This shows the gnomon in position. The upper arrow indicates the pivot on which it turns, the lower arrow shows the direction of the shadow vertically down the cylinder.

The whole of the dial-cap and cylinder, with the exception of the gnomon, was made of a light yellow wood. Vertical lines are scribed at intervals down the whole length of the cylinder; Figure 4 shows the development of these lines as if the surface of the cylinder were laid flat on a piece of paper.

The shank CD of the cap fits into the hollow AB down the centre of the cylinder. A saw cut has been made half way up the cap as shown in Figure 2 and a piece of tin-plate, Figure 5, inserted in the slot. This piece of plate constitutes the gnomon of the dial, and is pivoted at one end by a nail passing through one corner as indicated. The hole is drilled in such a position that, when the gnomon is in use, the long straight side of the tin-plate is underneath and projects at right angles to the cylinder. The long edge of the gnomon, resting on the flat top of the cylinder, is thus compelled to assume a horizontal position when the cap is pressed home as in Figure 3.

When not in use, the gnomon is twisted through a right angle and rests in the saw cut. Thus the dial can easily be carried in the pocket.

The vertical lines drawn down the cylinder correspond to the months of the year, the letters of the alphabet indicating the different months—D. for December, and so on.

Referring now to the developed cylindrical surface, in Figure 4, the vertical lines correspond to the lines on the cylinder, the letters at the bottoms to the months in the year, and the point marks on certain of the verticals, to calculated intervals measuring from the top of the cylinder. These intervals depend in length on the latitude of the place for which the sundial is designed, the time of day, and the particular length of gnomon taken—in this case three-quarters of an inch.

The vertical numbers, one, two, three, four, and so on, refer to the hours of the day. The cross-curves, drawn in red ink on the original cylinder, join up corresponding points on different verticals. As these points are mere indentations in the wood, made with some sharp instrument, they would quickly become obliterated by dirt or usage unless some distinctive marking were used.

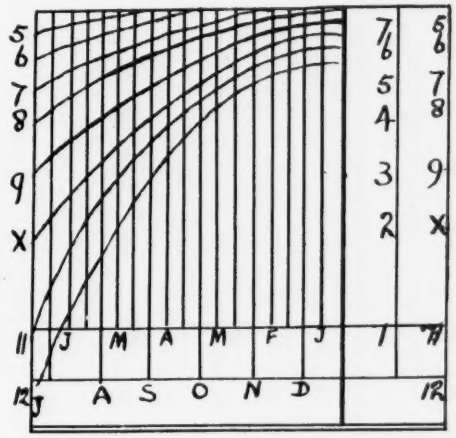


FIGURE 4.

The development of the cylinder.

In order to appreciate the action of the dial, consider the position of the earth with regard to the sun at different periods of the year. In the height of summer, when the sun is high over-head, if a stick of known length be held out parallel with the earth's surface—*i.e.*, horizontally—a shadow will be cast vertically down the body of the person holding the stick, which will be very long at mid-day, decreasing to zero at sunrise or sunset. Also at any particular period of the year the length of the shadow, measured vertically, cast by a horizontal stick, will vary with the declination of the sun and with the time of day—being, in general, shorter in winter than in summer.

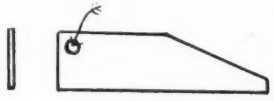


FIGURE 5.
The gnomon.

The gnomon of the sundial corresponds to the stick in the above illustration, and for a gnomon of given length it is a simple matter to calculate the length of the shadow which ought to be thrown on any particular day of the year, at any time of the day. As it is not possible to construct a dial with three hundred and sixty-five sides, a side for each day of the year, a certain interval only on the cylindrical surface of the dial can be allotted to each month.

These intervals are shown by the vertical divisions and sub-divisions on the developed plan.

The numbers 1, 2, 3, 4, and so on, refer to the hours of the day—1 for one o'clock, and so on.

At 12 o'clock the sun is high over-head, so that one curve represents this hour, but as the sun's angle at 11 is the same as it is at 1 o'clock, each of the other curves can represent the hours in pairs before and after noon.

The vertical for December indicates that the sun rises about seven, because only the curves for 7, 8, 9, 10, 11 and 12 o'clock pass through it. On the other hand the June vertical starts with a point almost at four o'clock, all the curves subsequent to this number being marked upon the vertical.

Although the above description is, of necessity, somewhat lengthy, yet the manner of reading the dial is simplicity itself.

Take the conical top out of the cylinder and after putting the gnomon in a horizontal position replace the cap, jamming it firmly into the top of the cylinder so as to hold the gnomon in that position (Figure 3), but before jamming turn the top round so that the sharp edge of the gnomon rests opposite the vertical for the day of the month in question.

Hold the cylinder vertical, a piece of thread is attached to the cap for the purpose, and spin the dial round until the shadow cast by the gnomon down the cylinder is vertical. The end of the shadow will show the time of day, the reading being taken from that vertical most nearly coinciding with the shadow, while the curves allow an accurate interpolation to be made.

No very great accuracy can be expected from such a simple and cheap instrument, but an accuracy equal to that of a small sundial might be anticipated.

Like all sundials, this curious instrument can only be used in the latitude for which it is designed, though in such a small dial considerable margin in this connection might be allowed.

This particular dial is quite modern in appearance, though there is no indication of the place of manufacture upon it. The writer was given to understand that it was found in use amongst the shepherds in the North of France, though the principal dimensions of the dial, including the gnomon, are in inches, and denote in consequence an English or American origin. It is almost certainly a copy of some older form.

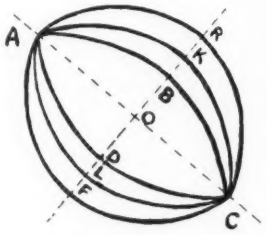


FIGURE 6.

Angle between the two planes BOADC and KOALC=sun's declination on any day of the year. At Midsummer these two planes will coincide.

The elementary mathematical theory evolved is as follows (see Figure 6) :—

(1) AOBCD is the plane of the sun at meridian.

(2) ROAFC is the equatorial plane at right angles to this plane.

(3) KOALC is any plane within $23\frac{1}{2}°$ N. or S. of the meridian plane.

Then if the sun is supposed to rise at A and set at C on any particular day of the year, it will pursue such a path as ALCKO.

Suppose P be any point on the same paths on this day. Join PO, PB, BK and KO.

Then PKBO is a right-angled spherical triangle of which the angles POK, KOB are known, KOB being the sun's declination from the vertical and POK being 90°—hour angle.

The solution of this triangle will be found in any good work on surveying, and is of the form

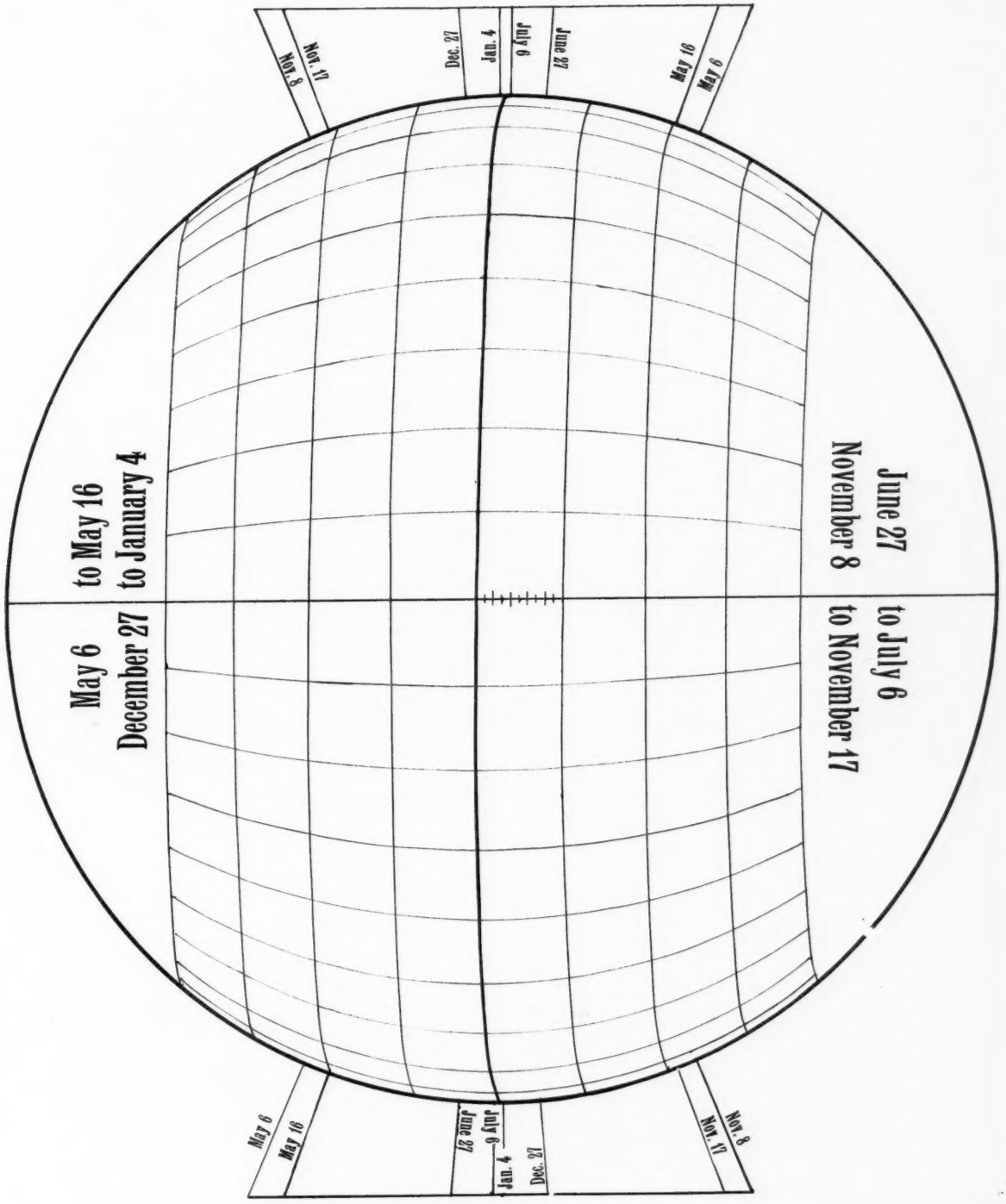
$$\cos \alpha = \cos \beta \cos \gamma,$$

where α β and γ are the angles of the spherical triangle.

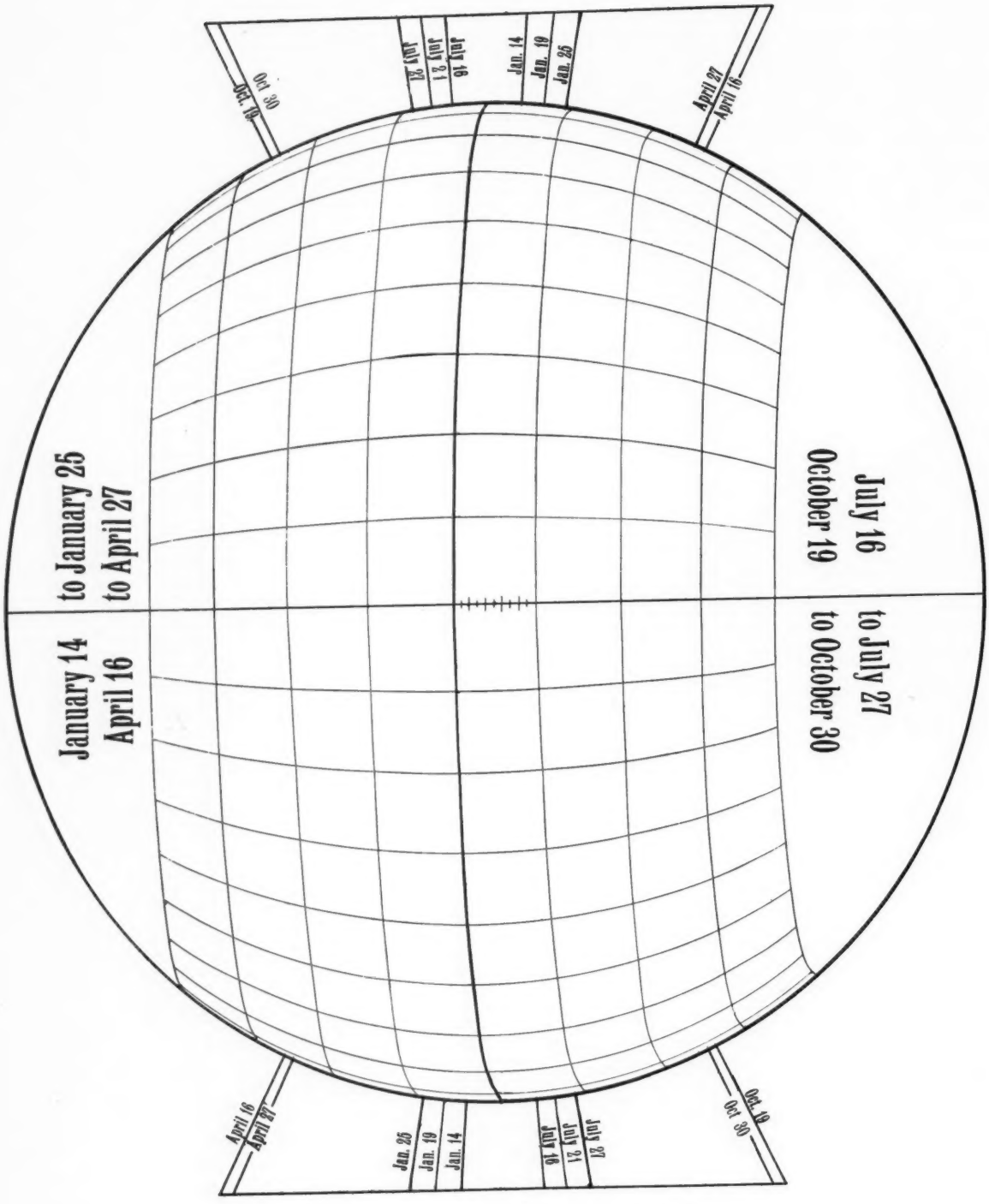
DISCS FOR SOLAR PROJECTION.

By JOHN McHARG, M.A.

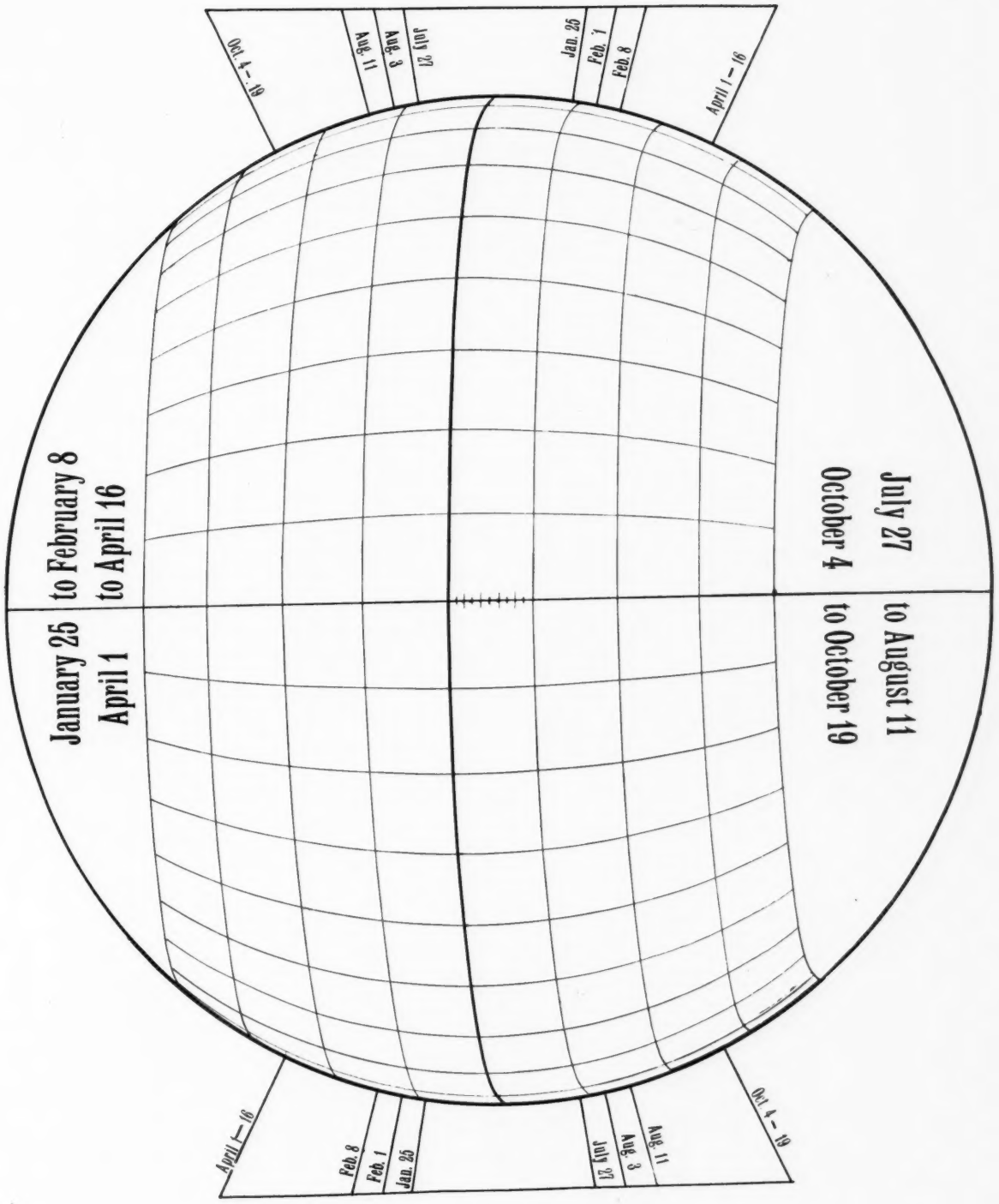
ON the following pages are given four more of the Maps for Solar Projection which complete the set. Number V. was printed on page 199 of this volume, while Numbers I., II. and III. appeared in the June issue for this year on pages 207 to 209. It is intended to reprint the series and issue them as a separate publication.



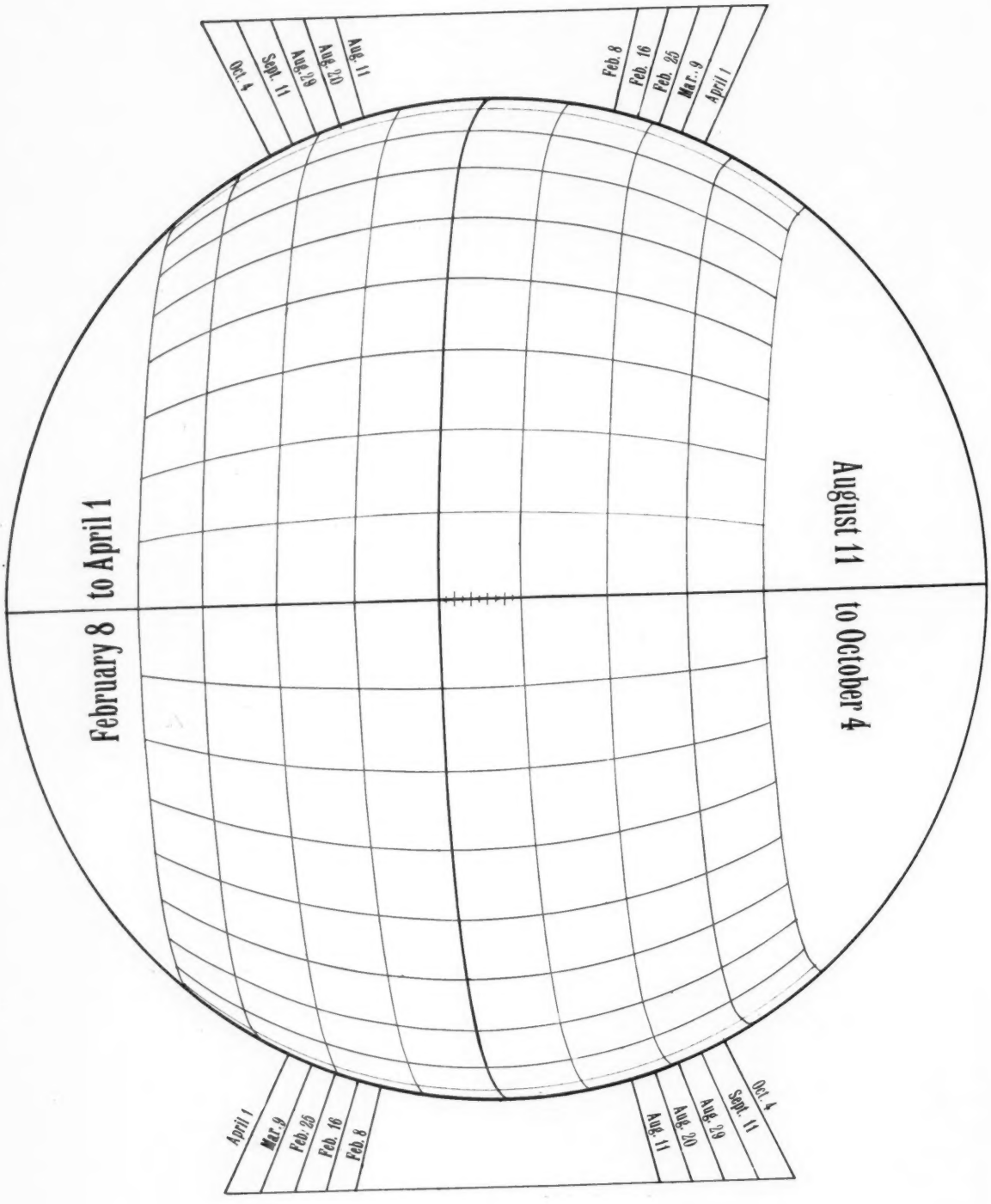
IV. Latitude of Centre ± 3°.



VI. Latitude of Centre ± 5°.



VII. Latitude of Centre ± 6°.



VIII. Latitude of Centre ± 7°.

CORRESPONDENCE.

ASTRONOMICAL QUERIES.

To the Editors of "KNOWLEDGE."

SIRS,—In the course of Astronomical study I have lately found difficulty on three points. I am venturing to lay these points before your readers, in the hope that a solution may be found me through the medium of your columns.

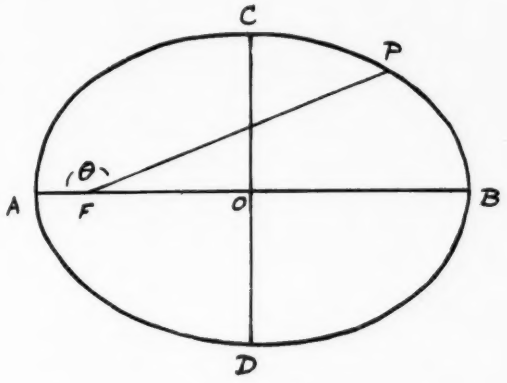


FIGURE 1.

Let a denote the semi-major axis, AO,
b „ „ „ minor „ CO,
e „ „ ellipticity, $\frac{FO}{AO}$,
r „ „ variable radius vector, PF,
T „ „ complete period of revolution,
S „ „ perimeter of the ellipse, that is, the rectified complete path of the body,
R „ „ arithmetic mean of the greatest and least values of r,
R_t „ „ time-average value of r,
R_a „ „ angle-average „ „
R_o „ „ orbit-average „ „

Then $R = \frac{BF + AF}{2} = \frac{BO + FO + AO - FO}{2} = a,$

$$R_t = \int \frac{r}{T} dt = a\left(1 + \frac{e^2}{2}\right),$$

$$R_a = \int \frac{r}{2\pi} d\theta = b,$$

$$R_o = \int \frac{r}{S} ds = a.$$

I.—A uniformly illuminated surface, whatever be its form and whatever be the angle made by the line of sight to its component parts, will appear uniformly illuminated wherever the eye be placed; the amount of light that reaches the eye will be proportional to, and depend only upon, the intensity of the illumination and the solid angle subtended by the boundaries of the surface at the eye. A familiar illustration of this is the case of an opal gas globe illuminated by a gas flame at its centre. The globe appears as a flat uniformly illuminated disc from all positions. This phenomenon is well-known and readily explained. In the case, however, of a surface illuminated by a point-source of light, and shining by reflection, the intensity of illumination varies with the angle of incidence, being, in fact, proportional to the cosine of that angle. Considering the case of a sphere, the intensity falls off to zero at the terminator of the illuminated portion. To an observer, then, such a sphere does not show the same intensity at the different portions of its surface; and the amount of light that reaches the eye depends not only on the solid angle the illuminated surface subtends at the eye, but also on the varying intensity of illumination, due to the varying angle of incidence of the light.

Now the *Nautical Almanac*, in calculating the time of greatest brilliancy of Venus, assumes that the illuminated portion of the planet visible from the earth is of uniform intensity, and that the brilliancy varies only with the solid angle subtended at the earth. Godfray in his "Treatise on Astronomy" gives the same method of calculation. Why should an approximately accurate result be expected on such an assumption?

II.—What is the usual interpretation of the expression "mean distance" as applied to the radius vector of a body revolving in an elliptical orbit about its primary?

The following interpretations occur to one, and there are doubtless others.

(*a*) The arithmetic mean of the greatest and the least value of the radius vector, which has the value a (see Figure 1).

(*b*) The average value at equal intervals of time which is $a\,(1+e^2/2)$.

(*c*) The average value at equal increments of the angle made by the radius vector, which is b.

(*d*) The average value of the radius vector at equal intervals of path of the body in its orbit, which is a.

One reads frequently of the "mean distance" without qualification; its value is generally taken to be the semi-major axis; but the time-average value would seem to be an important interpretation, and this is not the semi-major axis.

III.—It is recognised that the secular acceleration of the moon's mean motion is partly accounted for by change in the perturbation of the moon by the sun as the earth's orbit slowly becomes less elliptical. Here is a difficulty I cannot solve. I will endeavour to state it.

With decrease of ellipticity the time-average value of the earth's radius vector, $a\,(1+e^2/2)$, grows less. As the radius vector decreases the sun's perturbing influence on the moon increases. With increased perturbance the moon's motion is retarded. But the moon is known to be accelerated. There is then some flaw in the above reasoning which I cannot find. I crave help from one of your astronomical readers.

HAMPSTEAD, N.W. C. O. BARTRUM.

THE FOURTH DIMENSION.

To the Editors of "KNOWLEDGE."

SIRS,—I was very greatly interested in Mr. A. L. Annison's paper on "The Fourth Dimension" appearing in your issue for June, 1911. The writer, I think, very clearly shows that there is no valid reason why the "fourth dimension" should not actually exist; but, it may be asked, does this amount to a proof that the "fourth dimension" does actually exist? I hardly think that we may answer, yes; and it is for this reason that I venture to write to you, sirs, in order to call attention to my own work upon the subject, because I believe that I have been able to demonstrate, assuming the truth (1) of the Euclidean conception of space, (2) of the principle of the continuity of mathematical law, that the fourth and higher dimensions do actually exist; the existence of a third dimension of space implying that of a fourth, and so on, to infinity. As to the first of the above postulates (the truth of the Euclidean conception of space), all our experience supports it; but at the same time, I believe the wording of my proof might be modified so as to apply in the cases of the elliptic and hyperbolic space-hypotheses as well as the parabolic or Euclidean. As to the second postulate, this is altogether in accord with all our experience, and is, therefore, rightly employed in discovering facts which lie without the same.

A *very* brief statement of my proof, which was originally

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presented at a meeting of the Polytechnic Mathematical Society, appeared in a letter to the then editors of "KNOWLEDGE," which appeared in "KNOWLEDGE" for July, 1908 (Vol. V, page 157). A fuller statement will be found in my "Matter, Spirit and the Cosmos" (Rider, 1910), Chapter 6, together with some speculations bearing upon the same subject.

Thanking you in anticipation for affording this letter the hospitality of your columns.

H. STANLEY REDGROVE.

THE POLYTECHNIC,
REGENT STREET, W.

OBSERVATION OF URANUS AND MARS.

To the Editors of "KNOWLEDGE."

SIRS,—Uranus was observed on the early morning of July 1st, being located by aid of the circles on the equatorial of my three-inch Mogey refractor; this is the first observation of this planet I have made this year. It was pale blue or green in colour, quite bright, and very attractive in its field of few other and fainter stars. It presented quite a sensible disc, power eighty-four diameters, and appeared as it usually does, *i.e.*, pale and diffused, like a star slightly out of focus. It is of about magnification six, probably some brighter, and is easily visible in the one and one-eighth inches finder of my three-inch telescope; as it is the only bright star in its locality, it should be easily distinguishable even with an opera glass. Probably Uranus would be visible to the naked eye in clear air, especially as it is in an isolated position, to speak relatively.

Mars was also observed on the morning of July 1st. The disc was rather large and very reddish, powers eighty-four and one hundred and twenty-six, and was very beautiful; near a small star. The South polar cap was easily observable, eighty-four and one hundred and twenty-six diameters, in my three-inch instrument, and was attractive, being almost circular and very white. At and around the South polar regions, the disc was lighter than elsewhere and seemed to shade off gradually into the cap. At or near the equatorial regions, an apparently large continuous marking, running horizontally, was seen, very similar to those visible in the fall of 1909, through my two and a half inches refractor. This marking was dark green in colour, and extended nearly the entire distance across the disc, and at places was observed to be somewhat irregular in outline. The planet also seemed to be slightly gibbous on this date.

FREDERICK C. LEONARD.

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SOLAR DISTURBANCES DURING JUNE, 1911.

By FRANK C. DENNETT.

THE Sun has been very free from spot disturbances during the month of June. On the eleven days June 7, 8, 10-14, 16, 18, 19 and 24, there appeared to be a complete absence of disturbance, and probably the 25th should be added, although no observations have come to hand for that date. Only faculic markings were seen on the disc upon the nine days June 6, 9, 15, 17, 20-22, 27 and 28, and some of these appeared to be temporary in character. The longitude of the central meridian at noon on June 1st, was 102° 45′.

No. 24 remained visible until June 5th, and so appears on the present chart in its position on the 2nd.

No. 24*a*.—A group of four small pores, 15,000 miles in length on the 2nd, which in the afternoon appeared to be developing into an elliptical outbreak, but only the leader continued visible on the 3rd. The area was marked by faculae, upon the 4th and 5th, which was joined to that surrounding No. 24.

No. 25.—A group of pores, three in number, only seen on June 23rd.

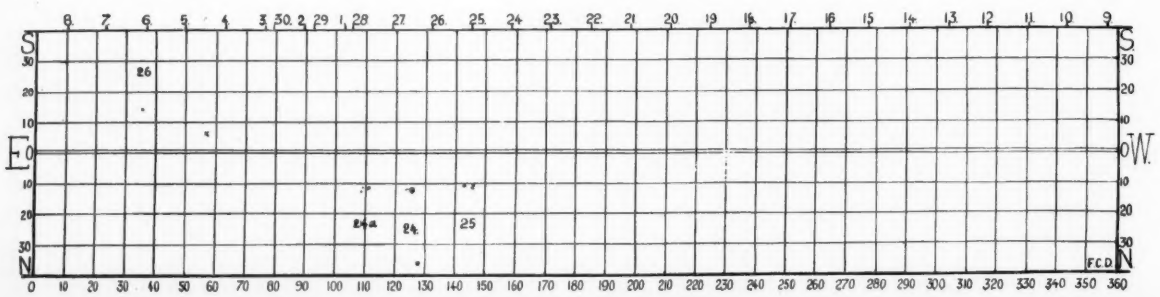
There was a greyish pore visible on the morning of June 28th in a pale faculic cloud near longitude 57°, South latitude 6°, marked by a cross on the chart, but not seen in the evening.

No. 26.—A spotlet, without penumbra, seen on the 29th and 30th only.

Whether studied with the telescope or spectroscope, the amount of disturbance is very small. The spots are generally of an evanescent character, and are mostly found recurring in the same districts of the solar surface, as may be noted by comparing the monthly charts together. Of the thirty-one spot disturbances recorded during the past six months seven were northern. Of these one was in longitude 7°, four between 103° and 146°, one close to the equator, 170°, and one at 226°. Of the twenty-four southern ones nine are between longtitudes 35° and 86°, two between 120° and 130° eleven between 165° and 203°, and the remaining two between 243° and 253°. The intervening areas are thus left seemingly without disturbance, in fact, from longitude 146° right round to 103°—317°—in the northern hemisphere, only three tiny outbreaks occur. The longest vacant district in the southern hemisphere—140°—is between 254° and 35°, three smaller ones occurring between 86° and 120°, 130° and 165°, and 203° to 243°.

Our chart is constructed from the measures and drawings of Messrs. J. McHarg, E. E. Peacock, and F. C. Dennett. Absence from home has unfortunately prevented Mr. Buss from sending in his work in time to be included this month.

DAY OF JUNE, 1911.



NOTES.

ASTRONOMY.

By A. C. D. Crommelin, D.Sc., B.A.

COMETS.—Two comets have been found in the last few weeks. One is Wolf's Periodic Comet, a well-known member of the Jupiter family, which was photographically detected by its original discoverer, Dr. Wolf, when only of the fifteenth magnitude. It was extraordinarily close to the place predicted by M. Kamensky, the error being $0^s \cdot 5$ in R.A., $6''$ in Decl. This comet will not pass perihelion till February, 1912, and is, therefore, still at a considerable distance from the Sun.

The other comet is an unexpected one, and promises to be faintly visible to the naked eye. In fact, M. Belopolsky gives its magnitude as 4·0, on July 9th, and states that it had a tail $\frac{1}{2}°$ in length, in direction 285°. The comet was discovered on July 6th, by Mr. Kiess, at the Lick Observatory, and will therefore bear his name. Professor Kobold, of Kiel, has deduced these elements: Perihelion passage, 1911, June 20·64, Berlin M.T., Omega 99° 32′, Node 172° 28′, Inclination 148° 39′, Perihelion distance 0·7932. The comet is now receding from the Sun, but at the same time its position in the sky is becoming more favourable, as it is getting $1\frac{1}{2}°$ further from the Sun in angular distance each day, and is also rapidly approaching the Earth, which it will continue to do till nearly the end of August, when it will be distant some thirty-five million miles, and observable for the greater part of the night.

An interesting feature in this orbit is its close resemblance to that of the comet 1790 I, which was discovered by Miss Caroline Herschel in January, 1790, but only seen on four days. When the new comet has been observed for a month or so, it will be possible to decide the question of identity. Even a close resemblance of orbit is not a proof of identity, for there are several instances of families of comets that travel in practically the same path. The most striking instance is that of the very brilliant comets of 1843, 1880, 1882, 1887. There can be little doubt of common origin in these cases.

This generation has probably seen its last of Halley's comet. Professor Barnard followed it visually till May 24th, and it was photographed at the Lick Observatory till May 27th. It was then outside Jupiter's orbit, and the total period of observation is one and three-quarter years. Doubtless further attempts at photography will be made when it emerges from the sun's rays in the autumn, but their success is doubtful.

It is likely that the large number of periodic comets that have been visible during the last two years has distracted the attention of observers from the search for new ones. I would suggest this as a promising field for amateurs with leisure for sweeping; a three-inch telescope with a low-power eyepiece is sufficient equipment; I think few have seriously taken up this work without success before very long.

THE EIGHTH SATELLITE OF JUPITER.—In addition to the photograph obtained at Helwan, Egypt, Dr. Wolf, at Heidelberg, and Mr. Innes, at Johannesburg, have succeeded in obtaining images of this seventeenth magnitude satellite. This success is very satisfactory in view of the fact that it will be unobservable at Greenwich till 1915, and gives ground for hope that the interval will be bridged over satisfactorily. A number of minor planets, both old and new, were recorded on the plates. About seven hundred of these little bodies are now definitely numbered, and hundreds more have been observed, but their orbits are not accurately known. The zone shows no signs of exhaustion, and the calculation of their orbits and ephemerides is a severe tax on the Berlin Recheninstitut.

TOTAL ECLIPSES.—The eclipse of last April was not a complete failure as observed from Vavau and neighbouring islands in the Pacific. Records of the general form of the corona (approximating to the type of sunspot-minimum) were obtained and we may hope for a few spectroscopic results. But evidently the great humidity of the climate was a drawback, as the fall of temperature caused condensation of vapour. There is a favourable totality in October, 1912, the track crossing Brazil, and emerging a little west of Rio. It is expected that two parties will go from this country to view it, and doubtless other nations will be represented. In April, 1912, there will be totality for a second or two in Portugal and N.W. Spain. It will be a particularly favourable occasion for obtaining impressions of the reversing layer all round the sun, and it should be possible to photograph the inner corona with rapid plates. Great care will be required in selecting a station, its accurate longitude and latitude must be known, as the track of totality is less than a mile broad. Those who desire to witness the eclipse as a spectacle without doing serious work may go to the north-west outskirts of Paris. There will not be absolute totality there, but I anticipate that there will only be a few small patches of sunlight through depressed portions of the moon's limb, not a complete ring. This eclipse is a return after the triple Saros of that of 1858, the last central eclipse in the British Isles. The next will be 1921 (annular, Hebrides and Shetlands) and 1927 (total across Wales and England).

BOTANY.

By Professor F. Cavers, D.Sc., F.L.S.

ORIGIN OF CHLOROPLASTS IN SEEDLINGS.—Two widely divergent views have been held with regard to the origin of chloroplasts (chlorophyll grains) in seedlings. According to one view, the chloroplasts originate directly from the general protoplasm of the cell, the mature seed itself containing no chloroplasts. Another group of investigators maintains that the protoplasm of the cell never gives rise to chloroplasts, but that the fertilised egg contains plastids derived directly from the parent plant, and that during development of the egg these multiply and thus provide every cell of the embryo with chloroplasts.

According to Sachs, the chloroplasts arise in the young cells by the separation of the protoplasm into portions which remain colourless and others which become green and sharply defined. He held that the process takes place by very small particles, originally of a different nature from the apparently homogeneous protoplasm in which they are distributed, collecting at definite places and appearing as separate masses.

Mikosch, after examining the seeds and seedlings of the sunflower, concluded that there are no plastids in the resting seed, but that during germination the chloroplasts arise directly from the protoplasm of the cells, owing to condensation of the protoplasm in definite places, this condensation being probably due to loss of water in these parts, which soon become green. The process occurs independently of light, and the bodies thus formed are at first rod or spindle shaped, but later assume the typical disc shape of the chloroplasts.

Belzung, after a long investigation of the ripening seeds, mature resting seeds, and seedlings of many plants, came to the following conclusions: (1) the free growth of starch grains can take place without the intervention of plastids; (2) the chloroplasts are formed directly by differentiation of the protoplasm; (3) the chloroplasts can also be formed at the expense of the starch grains which have their origin in the protoplasm of the cell. According to Belzung, the young embryo contains no chloroplasts, the starch grains formed in it are laid down in vacuoles of the protoplasm, and the green colour of the embryo in many plants is due to green pigment distributed through the protoplasm. No chromatophores are present in the embryo, consequently there are none in the mature seed. At germination the simple starch grains of the seed disintegrate, and numerous compound grains of transitory starch appear in various parts of the protoplasm. Each large

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vacuole is composed of from two to five smaller ones, in each of which a small starch grain is formed, and as the compound grain thus formed disappears, the green pigment passes in and thus a chloroplast is formed.

Meyer and Schimper, on the other hand, concluded that the origin of chromatophores does not take place in the young cell in any of the cases investigated by them, but that all chromatophores are derived from other cells in which they previously existed, increasing in number by division. Schimper found chloroplasts in the embryo-sac and the egg-cell, and concluded that the chloroplasts thus present in the young embryo persist in the ripening seed, but become colourless and lose their function, again becoming green and functional when germination occurs.

Bredow made extensive observations on seeds, and found that chloroplasts were always present, though often staining very poorly and being therefore hard to detect. Bredow used chiefly picric acid, which colours all proteid material yellow, but stains plastids more deeply than the other cell contents. He found that the chloroplasts of the seed increase during germination by simple fission, and also by the division of one chloroplast into as many as ten or twelve small ones by numerous irregular divisions. He pointed out that the greening of these numerous small bodies led the earlier observers to conclude that the chloroplast originates directly from the protoplasm of the cells of the seedling.

Famintzin made still more detailed observations on the origin of chloroplasts in seedlings, and especially on the manner in which the chloroplasts, if present in the seed, increase by division. Applying various microchemical reagents and stains, and using chiefly the sunflower, Famintzin was able to distinguish between the protein grains on one hand, and the chloroplasts and other protoplasmic structures on the other. He found that most of the chloroplasts in the resting seed lie in the film of protoplasm which surrounds each of the protein grains. On placing fresh sections in the light, he observed that these small bodies on the protein grains took on a yellowish colour, and by identifying these bodies in various stages of the seedling, he concluded that the sunflower seed contains chloroplasts, which by simple fission produce those of the seedling.

The latest investigator of this subject is Miller (*Bot. Gazette*, 1911), who has just published the results of his observations on the sunflower, applying the modern methods of fixing, microtome section-cutting, and staining. Miller confirms the statements of Bredow and Famintzin, who showed that chloroplasts are present in the resting seed and give rise to those of the seedling. Instead of beginning with the young embryo, and working onwards to the seedling, however, Miller has adopted the better method of working back step by step from the seedling to the seed. According to Miller, the chloroplasts in the early stages are present in the usual position in the cell, namely, just within the cell wall. He found the numerous small bodies clustered about the protein grains, but he does not agree with Famintzin that these are the chloroplasts.

ALGAL COAL.—The petroleum-yielding coals known as bog-head, cannel, and so on, have been supposed to owe their origin to Algae. This view, put forward by Renault, Bertrand, Potonié, and other workers in fossil botany, has been somewhat widely accepted. The chief evidence of such an origin is the occurrence in these coals, as well as in bituminous schists and oil shales, of abundant spherical or oval bodies, often arranged in layers, these bodies being interpreted as colonial Algae. They have recently been investigated by Jeffrey (*Proc. Amer. Acad.*, Vol. XLVI., 1910), who has elaborated a method for obtaining numerous thin sections in series, the result being that the structure, and by inference the nature, of these bodies can be brought out with a clearness not hitherto possible.

Jeffrey shows that these bodies are certainly not Algae, but the spores of Pteridophytes and other fern-like plants, which formed an important part of the Palaeozoic flora and which have always been regarded as largely responsible for the formation of ordinary coal. This conclusion destroys the Algal theory of the origin of petroleum and similar substances, and refers such products to the waxy and resinous spores of Pteridophytes, which were laid down on the bottoms of the shallow lakes of the Coal Period. These lacustrine layers, the mother-substance of petroleum, form either cannels, bog-heads, or bituminous shales, according to the proportion of spores and the admixture of earthy matter. Pressure and temperature, either separately or combined, in the presence of permeable strata, have brought about the distillation of petroleum from such deposits.

ALKALOIDS AS PLANT FOOD.—It has always been supposed that the various alkaloids found in plant tissues are purely waste products, not entering again into metabolism. However, some recent observations by Comère (*Bull. Soc. Bot. France*, Vol. LVII., 1910) appear to show that some of the alkaloids can be used as food materials. In fact, Comère finds that some alkaloids can be used by plants as the sole source of nitrogen. He worked with the freshwater Algae *Ulothrix* and *Spirogyra*. The alkaloids used (morphine, atropine, cocaine, quinine, and strychnine) were added gradually as assimilated, so that the plants were never subjected to strong solutions. The plants readily assimilated morphine and atropine, and less readily cocaine. Quinine, however, could not be assimilated, while strychnine proved very poisonous even in great dilution.

RESERVE FOOD IN BORDERED PITS.—It has become a commonplace that the most familiar plant repays renewed investigation. A short time ago, it was found that the so-called "scalariform tracheïds" of the common male fern and the Bracken, which have served generations of botanical students as types of the fern alliance for dissection and laboratory work, are in reality true vessels similar to those in the wood of the higher plants. Recently, Lakon (*Ber. deutsch. bot. Ges.*, 1911), has shown that the familiar bordered pits in the tracheïds of the common coniferous trees, Scots pine and spruce fir, contain at certain stages numerous starch grains and oil drops, and therefore evidently serve as storehouses of food in addition to their ordinary functions in connection with transport of water. Lakon states that while making observations on the reserve foods in various trees, he noticed starch and oil in the pits of the tracheïds. At first he thought that some starch and oil must have simply got into these pits by accident from the parenchyma cells of the medullary rays, in the process of section cutting. However, on making more careful preparations he proved that the starch and oil actually occur in the pits, even where the tracheids are not in contact with parenchyma cells, and he found them in microtome sections of material embedded in paraffin—that is, under circumstances which precluded the possibility of the accidental passage of starch and oil into the tracheïds from the other tissues of the wood.

Having clearly established the fact itself, Lakon proceeds to its explanation. Two alternatives are possible:—(1) the starch and oil may have been left behind in the pits while the tracheid was developing from a living and food-bearing cell; (2) some of the protoplasm of the tracheïd-forming cell may have persisted in the pits, the glucose in the cell-sap being later converted into starch and oil. Lakon inclines to the second explanation. He finds that during the winter, when the parenchyma cells of the rays contain only oil, the pits of the tracheïds also contain oil and not starch; and that in spring, when the parenchyma cells contain much starch and little oil, the same change occurs in the pits. Since a change of this kind could hardly occur in the absence of living protoplasm, it appears probable that such protoplasm is present in the bordered pits, and Lakon was able to demonstrate this in some cases.

Lakon states that in the literature there is only one recorded case where protoplasm, starch and oil occur in the fully developed conducting tissue elements of vascular plants, namely, in the stem of various species of plantain (*Plantago*). In the conifers investigated by Lakon, the protoplasmic

remains, with the starch grains and oil drops, may persist for several years; they occur only in the younger parts of the wood, but as far inwards as the fifth or sixth annual ring.

AMBROSIA FUNGI.—In continuing his interesting series of papers on Ambrosia Fungi, which have already been noted in "KNOWLEDGE," (May, 1910), Neger adds some further details (*Ber. deutsch. bot. Ges.*, 1911). Neger applies the term "ambrosia" to the Fungus cells which the associated insects eat, as well as to the insects themselves. The insects, including various beetles, mites, and so on, bore in the bark and wood of trees, and the cavities of the galls or tunnels they produce are lined by the Fungus layer which produces the special spherical "ambrosia" cells, serving for the food of the insect. This is, doubtless, a curious case of symbiosis, or mutually beneficial partnership, the insects on one hand being well fed by the Fungus, while the Fungus on the other hand takes advantage of the boring of the insects to gain entrance to the plant tissues and also gets a better supply of air opened up for it.

In his last paper, Neger concludes that the association between the boring beetles and the Fungus is an adaptation on the part of the former to life in wood poor in food substances. The ambrosia-seeking insects are much commoner in the warm and tropical zones than in the cool temperate regions, and they occur not only in standing trees but also in fallen ones, which are not yet dead. In the tropics, such insects often cause great damage to valuable trees yielding rubber, coffee, tea, and so on. This destructive action is not due merely to the attacks of the insects themselves, but to the fact that they introduce the Fungus to the conducting tissue of the wood, and probably more harm is done by the parasites which gain admittance in this way than by the Ambrosia Fungus on which the insects feed.

Neger has cultivated the Fungus found associated with various wood-boring beetles (chiefly species of *Xyleborus*) in order to obtain the spores and to determine its systematic position. Apparently the majority of the Ambrosia Fungi are either identical with, or closely allied to, the simple Ascomycetous genus *Endomyces*.

CELLOSE AND CELLASE.—It has long been known that, just as starch is converted into grape sugar (glucose) by the action of the ferment diastase, so cellulose—the chief component of the cell-walls of plants—is changed into glucose by the action of the ferment cytase. If, however, the hydrolysis of starch is incomplete, the resulting sugar is malt sugar (maltose), and it has recently been found that the corresponding product of incomplete hydrolysis in the case of cellulose is a substance called cellose. Bertrand and Holderer (*Bull Soc. Chim. France*, 1910), have discovered that cellose is converted into glucose by a special ferment, cellase. These authors find that cellose is not acted upon by such ferments as maltase, sucrase, and emulsin. This discovery indicates that there are probably many more ferments in plants than have hitherto been recognised, and that like so many other ferment actions, the digestion of cellulose takes place in several stages.

THE ECOLOGY OF CONIFERS.—The leaves of the conifers show markedly "xerophilous" structure, having thick cuticle, sunken stomata, reduced leaf-surface, poorly-developed air spaces, and so on,—all features characteristic of plants which grow in physically or physiologically dry places, and which must therefore check loss of water by transpiration. It is somewhat difficult, however, to reconcile this xerophilous structure with the fact that conifers often grow in places where apparently there is an abundant water supply, and it has been supposed that in such cases the xerophily is a character fixed by heredity. It has been suggested that the xerophilous leaf structure of conifers is due to the hereditary tracheïdal character of the wood—that is, the presence of narrow tracheïds instead of wide and open vessels—and the consequent limitation of the rate of flow of the water current. But this explanation breaks down, for the Larch shows a rate of flow of water equal to that seen in most dicotyledonous plants.

The assumption that a character shows hereditary fixity is one which calls for independent evidence, quite apart from the supposed incompatibility of structure and habitat. The recent work of Groom (*Ann. Bot.*, 1910) has shown that it is fallacious to judge of the xerophily of a plant from its leaf structure alone, and that a factor of fundamental importance is the total leaf area. Groom considers that the northern evergreen conifers are "architectural xerophytes," in which the extensive surface exposed by the evergreen leaves as a whole renders it necessary for the individual leaves to be xerophilous in structure. He thinks it possible that concurrent increases in the assimilatory surface, and in the xerophilous devices generally, increase assimilation in relation to transpiration; but that in the absence of detailed statistics bearing on the subject it is impossible to explain why the conifers should have adopted the device of having a large aggregate surface with a greater degree of xerophytism.

Coulter and Chamberlain (*Morphology of Gymnosperms*) adopt a similar view, implying that the plant is extremely plastic and that in matters of adaptation it will always come to adopt that habit and structure which give the greatest degree of efficiency under the given environmental conditions. Coulter and Chamberlain consider that the development of the small and stiff needle-like leaves or the concrescent scales of conifers from their assumed broad-leaved ancestors "cannot be regarded as the result of a general tendency among Gymnosperms quite unrelated to conditions of living; the leaf is too variable a structure and too closely related in its work to external conditions to permit such an explanation of its changes."

Compton (*New Phytologist*, March, 1911) criticises these views, and urges that the small-leaved type is the primitive one for conifers and is extremely stable. The primitiveness of small leaves in conifers is bound up with Seward's well-known theory that conifers arose from club-mosses (Lycopodiales), but even if the ancestors of the conifers were large-leaved plants, it must be admitted that the same type of small-leaved conifers had persisted from later Palaeozoic times to the present day. The variety in habitat of modern conifers is correlated with less variety in their structure, relations of leaves to stem, size of leaves, and so on, than in the case of Angiosperms. The larch, with its deciduous habit and lesser degree of structural protection against transpiration, but with its retention of the small leaves, is a striking example of the persistence of the typically coniferous form of leaf. The deciduous species of swamp cypress (*Taxodium*) and *Glyptostrobus* also inhabit swampy places without modification of the type of leaf form. In *Phyllocladus* the plant has resorted to the device of producing flattened branches instead of increasing the size of its leaves.

It would appear, therefore, that the coniferae have small power to vary the character of their leaves. The predominant types—the needle-like leaves of pines, firs, larch, cedar, and so on, the lineal lanceolate leaves of yew, and so on, the scale-like appressed and concrescent leaves of cypress, and so on,—are all closely related to each other. The leaf development is in all cases small compared with that of the stem—that is, the conifers are fixedly small-leaved. This appears to be connected with the absence of lateral veining of the vascular bundles in the leaf. In most cases a single or double bundle runs from end to end of the leaf without branching; and even in Araucarias and other forms, where the leaf is broader and many-veined, there is not found that copious lateral branching and anastomosing of the veins which is associated with the free branching of so many dicotyledonous leaves. The failure of the bundles to branch is to some extent compensated by the development of transfusion tissue—this is also found in some fossil lycopods where the same limitation of the power of branching prevails, along with small leaves and often xerophilous structure.

Hence it appears that the conifers are rigidly small-leaved forms, and that the power of freely adapting themselves to ecological conditions is strictly limited by the lack of plasticity in leaf structure. It is suggested that the lack of ability of the foliar vascular system to branch with ease is one of

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the causes which have contributed to keeping the leaf small, and that this failure may possibly be associated with the presence of transfusion tissue, which, though valuable in itself under the circumstances, may tend to prevent improvement in other directions, such as that of free pinnation of the veins.

Given this cramped hereditary type of structure, ecological adaptation appears to have been the result of two processes going on simultaneously: (1) the development of enormous numbers of the rigidly-constructed leaves with a view to increased assimilation and growth, and (2) the production of xerophily in the individual leaves as a compensation for the resulting increase of surface. It thus seems clear that the hereditary factor is of great importance in the ecological relationships of the conifers. It is conceivable that ecological adaptation may be achieved as efficiently by a suitable modification of the small-leaved type as by another kind of modification of a broad-leaved type—in fact, more than one kind of mechanism may be well adapted to a given set of external conditions. The conifers, however, are predisposed to the adoption of "architectural xerophily" as their mode of adaptation by the persistent hereditary factor of microphylly (possession of small leaves).

THE MAIDENHAIR TREE (*GINKGO BILOBA*).—One of the most interesting groups of Gymnosperms is that which is now represented only by the Maidenhair Tree. The Ginkgotype is of special importance because its reproductive organs show many resemblances to those of the lower Gymnosperms (Cycads and Cordaitales), while its vegetative anatomy resembles in many ways that of the Conifers, so that it may be said to form a connecting link between these groups.

The Maidenhair Tree, as the sole survivor of a family which was well represented in the Mesozoic Period, and perhaps much earlier, has naturally attracted a great deal of attention from botanists, and it is proposed here to summarise some of the literature on *Ginkgo* published during the last few years, including the most recent accounts.

Ginkgo is almost unknown in the wild state, though reported by travellers in the forests of western and south-western China, but it has been extensively cultivated, first in China and Japan, and later in Europe—there is a fine tree in Kew Gardens, for instance. Apart from the strong main trunk and wide-spreading branches, it hardly resembles in habit any of the other Gymnosperms, while its deciduous leaves, having a long slender stalk and a broad wedge-like blade with repeatedly forked veins (strongly suggesting the leaves of Maidenhair Fern), are so characteristic that they form unusually trustworthy evidence of the existence of the Ginkgoales when found in the fossil state. The tree reaches a height of about one hundred feet. The branches are of two kinds; the long shoots bear scattered leaves, while the short ones are dwarfed, slow-growing, and bear few leaves in a cluster. A dwarf shoot may after several years become a long shoot, bearing scattered leaves, and may then resume the slow growth of the dwarf shoot; sometimes it undergoes branching.

The general morphology and anatomy of *Ginkgo* have been described by Seward and Gowan (*Ann. Bot.*, 1900) and in greater detail by Sprecher in his invaluable monograph of this plant (Geneva, 1907), while various details have been added by recent writers. The stem shows the general structure of a conifer, having a narrow cortex, a thick compact zone of wood produced by a persistent cambium layer (contrasting with Cycads), and a relatively small pith (contrasting with Cordaitales); in thed warf shoots, however, the wood zone is narrow and the pitch large. As in the pines and other low conifers, there are well-marked annual rings, and the tracheids have opposite pits and "bars of Sanio."

Tupper (*Bot. Gaz.*, 1911) has shown that frequently the short shoots branch within the wood of the limb out of which they grow, this has recently been seen in a new Triassic Araucarian, *Woodworthia*, but in no other conifers so far as known, and confirms the view that the araucarian conifers are an old group and have possibly come from the same stock as the ginkgoales. Tupper also describes crystal cells and wood parenchyma as occurring in rows or series running longitudinally through the root of *Ginkgo* in radial planes; all these rows are in contact with at least one of the medullary rays, and Tupper suggests that the radial distribution of this parenchyma, as compared with the tangential arrangement seen in conifers, shows that *Ginkgo* is a primitive type.

The primary wood in the stem is endarch (with the earliest wood vessels innermost, and the development of the wood therefore centrifugal), but distinct mesarch structure (*i.e.*, part of the wood centripetal, the rest centrifugal, therefore the protoxylem not innermost) occurs in the bundles of the cotyledons. The leaf receives a double bundle (leaf trace), as in all the more primitive gymnosperms, each bundle forking at the base of the blade and breaking up into the forking system of veins, some of which show traces of centripetal wood and therefore indistinct mesarch structure. The veins are not joined up into a network, so that if a few veins are cut across near the base of the leaf, long streaks of the leaf become withered and dry. The leaves vary much in size and lobing, showing every transition from deeply lobed to almost entire, though typically there is a notch at the middle of the blade. The leaf structure resembles that in cycads; the stomata are chiefly on the underside, and between the veins the loose mesophyll cells are elongated parallel with the leaf surface.

The plant is dioecious; the flowers have no bracts, and they are developed on the dwarf shoots. The male flowers or cones consist of an axis bearing loosely arranged stamens; each stamen has a stalk ending in a knob which bears usually two pendent stamens, sometimes three or four or as many as seven. Miss Starr (*Bot. Gaz.*, 1910) has shown that in the young knob there develop, in addition to the stamens, patches of apparently sporogenous tissue which degenerate into mucilage cavities, suggesting that these cavities have replaced abortive sporogenous tissue.

The stamen of *Ginkgo* suggests comparison with the epaulet-like form seen in the "crossotheca" type of stamen in the pteridosperms. It may also be compared with the stamens of the cordaitales, the whole male dwarf shoot of *Ginkgo* corresponding to the male inflorescence of cordaites, which consists of a thick axis bearing bracts among which are inserted the stamens, each stamen consisting of a long stalk bearing at its tip a cluster of three to six erect pollen-sacs. If the sterile sporophylls in the *Cordaites* cone were suppressed, the general structure of the male flower of *Ginkgo* would be attained, but in *Ginkgo* the pollen-sacs are borne in a different way, being dependent on the lower side of the knob or reduced blade of the stamen. In *Antholithus zeilleri*, regarded as the male cone of *Baiera* (a Mesozoic member of the Ginkgoales), the stamens are repeatedly forked and bear eight pollen-sacs, one on each of the ultimate divisions. Whatever interpretation is placed on these different structures, the facts point to close relationship between ginkgoales, cordaitales and pteridosperms.

The female cones are much reduced, and are carried in groups on dwarf shoots. Each cone consists of a long stalk bearing at its tip two ovules, sometimes more, and below each ovule there is a narrow cup or collar. The latter has given rise to much discussion. Fujii and, later, Seward and Gowan, were led by the study of numerous abnormal forms to conclude that the stalk is a shoot bearing normally two rudimentary carpels represented by the two collars. However, Shaw (*New Phytologist*, 1908), examining the vascular structure of the flower, found that the bundles of the collar show inverse orientation, and suggested that the collar is no carpel but a vestige of the cupule that surrounded the seeds of the pteridosperm genus *Lagenostoma*. If correct, this would even more strongly point to an affinity between ginkgoales and pteridosperms. Shaw regards the general anatomy of the female axis and the occasional occurrence of an apical bud between the ovules as proof that it is a shoot bearing two lateral-stalked ovules, each ovule being attached to the axis by a short pedicel, with the collar at the junction between pedicel and ovule. On the other hand, the female axis has four bundles, which would be expected in a stem bearing two

leaves (collars) at its apex, and when there are more than two ovules on a stalk we find twice as many bundles in the stalk as there are ovules at its apex—just as there should be if each collar were a carpel.

The development of the microsporangium (pollen-sac) has recently been described by Miss Starr, and it mature structure and mode of dehiscence by Goebel. In development, apparently a single hypodermal cell divides to form the tapetal and sporogenous tissue, and, outside of the tapetum, the wall of the sac (except the outermost or epidermis layer). The wall consists of from four to seven layers of cells, the hypodermal layer and the layer below it being thickened by fibres serving for dehiscence. Goebel (*Flora*, 1902) has studied the structure of the wall of the ripe pollen-sac; apparently *Ginkgo* is the only gymnosperm that has an endothecium, the dehiscence layer or layers being of hypodermal origin; the longitudinal slits of dehiscence of the two pollen-sacs face each other, and lie at such an angle that the pollen is readily shed for wind dispersal.

The development of the ovule has recently been worked out by Miss Carothers (*Bot. Gaz.*, 1907), who extends the earlier accounts. The ovule resembles in general structure those of cycads and cordaitales, having the typical three-layered integument (outer fleshy, middle stony, inner fleshy), the apical beak of the nucellus, and the pollen chamber; but the set of bundles which in cycads and cordaitales traverse the outer fleshy layer are not present in *Ginkgo*, only the inner bundles in the inner fleshy layer. A single mother-cell (very rarely two mother-cells) functions, and lies among a mass of tissue which may or not be sporogenous, representing a many-layered archesporium, but at any rate functions as a tapetum nutritive tissue. In the mature mother-cell the reduced number of chromosomes is eight; the four spores formed by division of the mother-cell may be in a row, or three with the upper cell divided longitudinally. The tapetal tissue increases in bulk by division, during the tetred division of the mother-cell, and actively encroaches upon the surrounding nucellar tissue; the tapetal zone in its turn begins to be destroyed by the encroachment of the young gametophyte (endosperm), which invades and destroys the tapetal tissue and the surrounding nucellar tissue. The megaspore, which has a well-developed membrane, enlarges greatly, and its nucleus lies at the micropyle end.

Miss Carothers then describes the development of the female prothallus (endosperm). The megaspore, after its nucleus begins to divide, contains a large vacuole, hence the nuclei formed by division are from the first arranged just within the membrane, lying in the thin protoplasmic lining layer. Up to the stage with sixty-four nuclei, the free nuclear divisions are simultaneous, but later they become irregular, until there are over two hundred and fifty-six nuclei; meanwhile the whole ovule and the embryo-sac are enlarging, and the megaspore membrane becoming thicker. Previous to the formation of walls, a delicate but distinct membrane appears on the outer surface of the protoplasm of the embryo-sac, and to this membrane (not to the megaspore membrane, as previously supposed) the first walls of the endosperm are attached; then by the nuclear division and wall formation the prothallus becomes a solid mass of tissue. Before this process is complete, the endosperm becomes green, owing to formation of chlorophyll, as proved by examination with the spectroscope, and the cells are soon filled with starch grains—partly formed no doubt by the green endosperm itself.

The germination of the pollen-grains, the formation of the remarkable ciliated motile male cells, and the act of fertilisation of the two (sometimes three) archegonia were fully described by Hirasé in 1898, and little has been added to his account. Various more recent writers have, however, worked out the development of the embryo. The embryo of Ginkgo was formerly regarded as peculiar among Gymnosperms, owing to the absence of an elongated suspensor, such as occurs in Cycads and Conifers. In *Bennettites*, however, there was no suspensor. Arnoldi (1903) showed that the elongated pro-embryo of Ginkgo is differentiated into three regions:—(1) a micropylar haustorial region (2) a middle suspensor region, and (3) an apical region producing the embryo itself; this brings *Ginkgo* into line with the typical embryology of other Gymnosperms, though the suspensor remains short and thick. Another peculiarity in the embryo of *Ginkgo*—the complete filling of the fertilised egg with proembryonic tissue—has lost significance by the discovery that the same thing occurs in *Dioon* and probably some other Cycads. Lyon (1904) gave a very full account of the development of the embryo in *Ginkgo*, greatly amplifying the descriptions given by Strasburger (1872) and other previous authors; in some cases the pro-embryo apparently produces two embryos; three cotyledons occur not uncommonly, instead of two.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

USE OF COPPER FOR WATER PIPES.—The owners of a house in Paris, being anxious to instal copper pipes instead of the usual leaden pipes for their water supply, applied to the Prefect of the Seine for the necessary permission. The question was therefore submitted to the Municipal Laboratory in Paris, which reported unfavourably upon the proposal, and also to the Council of Public Hygiene, the head of which, Professor Armand Gautier, spoke strongly in its favour. In his report he pointed out that lead was really an unsuitable metal for water pipes, and that the purer the water the more rapidly was the metal attacked. Although the presence of sulphates in most drinking waters rendered the risk of poisoning insignificant, it was probable, he pointed out, that there would be trouble in the immediate future from this cause in the case of the particularly soft waters which have recently been supplied to the towns in the West of France.

This danger would be entirely obviated by the use of copper pipes, for although a dose of fifty to one hundred milligrammes of copper sulphate was poisonous, the system could soon become acclimatised to much greater quantities, and, as a matter of fact, several milligrammes were frequently absorbed daily without any ill effect in the food which throughout France was cooked in copper vessels. Experiments made by M. Gautier upon himself had shown that no ill effects were produced by acid food that had been cooked in copper utensils. Long before the poisonous dose had been reached a liquid contaminated with copper would have acquired a harsh metallic taste which would put the consumer upon his guard, and this would be the worst that could happen in the exceptional cases where water would attack the pipes. With leaden pipes, however, a poisonous dose could be present in the water without its being detected by the taste. There was, therefore, in his opinion, only benefit to be derived from the substitution of copper for leaden pipes for the supply of water to houses.

The report of Professor Gautier, the chief points of which are summarised above, is published in the current issue of *Biologica* (1911, VI, 79). His conclusions agree with those of the American chemists and doctors who have advocated the use of copper sulphate and metallic copper for the sterilisation of drinking water. Readers of these columns will also remember that copper sulphate is now used upon a large scale in America for destroying the pond scum upon the water reservoirs.

GRECIAN BLACK ENAMEL.—The rich black lustre upon Grecian and Roman pottery has long been attributed to the presence of manganese, but according to M. L. Franchet, who has recently studied the question (*Comptes Rendus*, 1191, CLII, 1097), the proportion of manganese is altogether insufficient to produce the effect upon the ancient vases. The suggestion made by Verneuil that the Greeks made use of metallic iron obtained by the reduction of an oxide, is not in accord with the statements of ancient writers, who assert that natural products were employed.

Since the mineral magnetite was known to the Romans, who obtained it from Piedmont, M. Franchet has made

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experiments with that natural ferroso-ferric oxide, and, by fusing it in an oxidising flame with quartz sand and sodium, has succeeded in reproducing the black enamel.

The richness of the lustre is probably increased by the presence of a trace of manganese in the magnetite. A similar enamel is found upon the Egyptian pottery, and it is probably from Egypt that the Greeks derived their knowledge of the art.

PROPERTIES OF ALUNDUM.—A fused form of alumina is now extensively used under the name of "Alundum" in the manufacture of crucibles and other vessels for which a refractory material is needed. According to Mr. L. E. Saunders (*Amer. Electrochem. Soc.*, April, 1911), the commercial product is usually a white crystalline substance containing less than one per cent. of iron oxide and other impurities. There is also a red-brown variety containing about five to six per cent. of impurities, and melting at about 2,000 to 2,050° C., or about 50° lower than the white alundum. The specific gravity of the latter is 3·93 to 4·00, and its heat conductivity is from three to four times as great as that of fire clay. It resists the action of aqueous acids and alkalies and is only slightly attacked by fused alkali carbonates. Crucibles of alundum may be used for melting metals with as high a melting point as platinum, though they are too porous to be used for melting slags. A cement for lining furnaces is also prepared from alundum, and has the advantage of not melting or combining with carbon at temperatures below 1,950° C. Bricks of alundum have also been used instead of silica for the roofs of electric furnaces.

THE TRANSFORMATION OF RADIUM.—Professor Rutherford, to whom we owe much of our knowlege of radio-active bodies, gives a most interesting survey in the *Journal of the Society of Chemical Industry* (1911, XXX, 659), of the principal results regarded from the chemical point of view. The three types of rays emitted by radio-active substances are classified as α, β, and γ rays in accordance with their penetrative capacity and effect upon a magnetic field. The α rays possess only slight penetrative properties, and are readily stopped by a metal plate. They appear to consist of streams of particles identical with the gas helium. The β rays are more penetrating and more easily deflected by a magnetic field, and are supposed to be identical with electrons; while the γ rays are exceedingly penetrating, are not deflected by a magnetic field, and have apparently properties analagous to those of the Röntgen rays.

Uranium is to be regarded as the first parent of the radium family. It is decomposed so slowly that about five thousand years would be required for half of it to be transformed into an element termed Uranium X, with an atomic weight of 230·5. This emits β rays, and is transformed into ionium, the direct ancestor of radium. Coming to radium itself, a continuous disruption takes place with the liberation of α rays (helium) and the formation of a new element, the radium emanation, which appears to be one of the inert gases. This radium emanation, in turn, breaks up with the expulsion of an α particle or helium atom and the formation of a new very unstable element, Radium A, which is rapidly transformed into another metallic element, Radium B, decomposing in twenty-six minutes, with the expulsion of β rays, into Radium C. The latter breaks up into Radium D, which in turn yields successively Radium E and Radium F. The element polonium has been identified with Radium F, and there is some evidence that the element formed in the decomposition of polonium is lead. The atomic weights and the nature of the radiations emitted by these successive elements are summarised by Professor Rutherford in the following table:—

	Radiation.	Atomic Weight.
Uranium	2α	238·5
Uranium X	β	230·5
Ionium	1α	230·5
Radium	1α	226·5
Emanation	1α	222·5
Radium A	1α	218·5
Radium B	β	214·5
Radium C	1α	214·5
Radium D	β	210·5
Radium E	β	210·5
Radium F	1α	210·5
End product	—	206·5 (lead?)

Many interesting details are given of the methods of examination employed in the investigation of these bodies, but, as Professor Rutherford points out, "the process of transformation cannot be influenced to the slightest degree by any chemical or physical agency. We are only able to watch these atomic processes, but cannot control them."

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

THE PROBLEM OF THE SCOTTISH HIGHLANDS.—A new interpretation of this classic region is put forward by Professor J. W. Gregory, in the *Transactions of the Glasgow Geological Society*, Vol. XIV (1910). The most disputed points are the age of the Dalradian System, and which is the top or bottom of its long succession of deposits. In regard to the first question, Professor Gregory believes the Dalradians to rest unconformably upon the Moine Gneiss, an extensive flaggy formation which stretches from the Central Highlands to the Pentland Firth; but from certain evidence in Islay, they are probably older than the Torridon Sandstone. Among the Dalradians themselves, the Loch Lomond Gneiss is believed to be the oldest. This is succeeded to the north by the Loch Tay, Ben Lawers, and Blair Atholl series, and the Schichallion Quartzite. All these rest unconformably upon the Moine Gneiss to the north and north-west, with the exception of the Loch Lomond Gneiss, which does not appear to come into contact with the Moine anywhere. Two further series, the Ben Ledi and the Aberfoyle, occur to the south of the Loch Lomond Gneiss, and appear to rest unconformably upon that formation. The great band of quartzite in the Central Highlands is, under this arrangement, the youngest rock in the Dalradian System, with the possible exception of the Aberfoyle Series. It rests unconformably upon the black schists of the Blair Atholl Series, and forms great cakes which have been carved into bold mountain masses such as Schichallion and Ben-y-ghlo. Two other horizons of quartzite or quartz-schist occur below the Schichallion quartzite. These separate groups have often been confounded together, and also with some portions of the Moine Gneiss, but they can usually be distinguished by their petrographical characters, as well as by their stratigraphical position. Professor Gregory concludes his paper with a series of suggestions as to useful research by Glasgow geologists on the south-western Highlands.

NEW MEMOIRS OF THE GEOLOGICAL SURVEY OF SCOTLAND.—The three interesting memoirs on Edinburgh, East Lothian, and the Glenelg district, recently issued by the Scottish Geological Survey, form very important additions to our knowledge of Scottish geology. The first two are new editions, but they are entirely new works, and their superiority to the first editions, issued forty or fifty years ago, is a measure of the advance in local geology during that period. The Edinburgh memoir is a volume of 445 pages, and contains numerous beautiful plates, as well as a geological map of Arthur's Seat. This classic hill, which renders the local geology as picturesque as Edinburgh itself, is fully described, and the description, together with the geological map, has been issued as a separate pamphlet at the price of sixpence. The oil-shale field of Central Scotland comes within the area described in this memoir. This industry has been developed since the issue of the first edition, and the new information made available by mining operations has rendered necessary great changes in the geology of the region.

The East Lothian Memoir describes rocks ranging from the Silurian of the southern uplands to the Coal measures disappearing under the Firth of Forth. The district includes the

interesting area of the Garlton Hills, made up mainly of trachytes, with some mugearites and basalts, and an occurrence of the rare kulaite (hornblende-basalt), all lavas of Calciferous Sandstone age.

A little-known and rather inaccessible, but beautiful, region is described in the memoir on "The Geology of Glenelg, Lochalsh and the south-east part of Skye." The geology is extraordinarily complex, as the area contains the southern ends of some of the great thrust-planes which are a feature of the north-west of Scotland. The relation of the Moine to the Lewisian gneiss is well displayed. The Moine is shown to rest unconformably on the Lewisian, with a basal conglomerate at some localities. Variety is given to the geology of the district by the inclusion of a portion of the Tertiary volcanic rocks of Skye, and of a series of highly fossiliferous Mesozoic strata, ranging from the Trias to the Upper Cretaceous.

The maps issued with these memoirs are colour-printed, and are the first Scottish maps to be so issued. They are a great improvement on the expensive and somewhat unreliable hand-coloured maps.

METEOROLOGY.

By JOHN A. CURTIS, F.R.MET.SOC.

THE weather of the week ended June 17th, as indicated by the Weekly Weather Reports issued by the Meteorological Office, was at first fair and dry in the South and West, but cool and showery in the North and East. Towards the end of the week rain set in very generally, and thunderstorms were experienced in many places.

Temperature was below the average in all districts except the English Channel, where it was 0°·2 above. The greatest difference from average was in Scotland E., where the mean was 4°·5 lower than the normal. The highest reading recorded was 76° at Killarney on the 11th, which was 8°·0 lower than the maximum of the previous week. At many stations the maximum did not reach 70°, and in the extreme North it was under 60°, only 54° at Lerwick. The minima ranged down to 28° at Balmoral and 30° at Llangammarch Wells. In the English Channel, however, the minimum did not fall below 46°. On the grass very low readings were recorded, 19° at Llangammarch Wells, 24° at Birmingham, and 26° at several stations.

Rainfall was generally deficient in the eastern parts of the country, and in Ireland N., but was in excess elsewhere, though not to any great extent. Sunshine was above the average in all districts and at nearly every station. The sunniest stations were Rhyl 76·4 hours (66%), and Jersey 70·5 hours (63%). At Westminster 50·8 hours (45%) were recorded, while at Glasgow only 35·7 hours (30%) were registered. The temperature of the sea water round the coasts varied from 49° at Lerwick and Pennan Bay, to 62° at Seafield.

The weather of the week ended June 24th, Coronation week, was generally cool and cloudy, though in the first part of the week there were fairly long sunny intervals. Thunderstorms were experiencd on Sunday and Monday. Temperature was normal in England N.W., below it in Scotland W., England S.W. and S.E., Ireland and the English Channel, but above it elsewhere, the variations from the normal being, however, but slight. The highest temperatures recorded were 74° at Greenwich on the 23rd, and 73° at Bawtry on the 22nd. At many stations the maximum was below 70°; the lowest readings were nowhere so low as in the previous week, and no reading below 40° was recorded. In London the minimum was 52°, and no ground frost was reported.

Rainfall was in excess everywhere and some very heavy falls were reported. At Shields and at Alnwick Castle the amounts exceeded 4·0 inches, which is more than eight times the usual quantity. At Westminster the total was 1·12 inches on five days. At Bath, though rain fell on each day of the week, the total collected was only 0·58 inches.

The district values of bright sunshine ranged from twenty-six hours (22%) in England N.W., to forty-four hours (39%) in the English Channel. Strangely enough, the two sunniest places were at the extreme North and South of our Islands, Stornoway reporting 49·1 hours (39%) and Guernsey having 49·6 hours (44%). At Stonyhurst only 11·2 hours (10%) were recorded. The temperature of the sea water varied from 48° at Berwick to 62° at Margate.

The week ended July 1st, was unsettled and rainy, with occasional thunder and lightning. Temperature was below the normal in all districts, by as much as 4°·4 in Scotland, W. The highest reading reported was 73° at York, Clacton, Raunds, Yarmouth and Tottenham. In Jersey, however, the maximum was only 63°. The lowest readings were 37° at Kilmarnock and 39° at Cally and at West Linton. In Westminster the extremes were 72° and 50°. On the ground the temperature fell to 27° at Llangammarch Wells, and to 31° at Armagh. Rainfall varied a good deal, but the departures from the mean were nowhere so severe as in the previous week. In Scotland N., the fall was about half as much again as usual, but in Ireland it was only one half the usual amount. Bright sunshine was in defect in all districts, the deficiency reaching 20% in the English Channel. Falmouth had the highest record for the week, 45·6 hours (40%), while at Weymouth 43·5 hours (39%) were recorded. Westminster had 26·6 hours (23%). The temperature of the sea water varied from 49° at Ballintrae to 63° at the Shipwash light vessel off the East Coast.

The week ended July 8th, began with unsettled rainy weather over Scotland and Ireland N., but with very fine weather in all other parts. By the end of the week the fine weather had extended to the Northern districts also. The average temperature was above the normal in most districts, though not markedly so. The individual readings, however, were exceptional and exceeded 80° in all parts except Scotland N. and W., and Ireland N. The highest readings recorded were 90° at Cullompton in North Devon, on the 8th, and 88° at Greenwich, Oxford, Raunds and Wisley. The minima were as low as 36° at Balmoral, and 37° at West Linton and Fort Augustus, but as a rule the lowest readings ranged between 40° and 50°, and were in some cases over 50°. Slight frost on the grass was experienced at Crathes (30°) and at Llangammarch Wells (29°), but in most places the grass minimum was above 35°. Rainfall was slightly above the average in Scotland N., but was in defect in all other parts of the country. At many stations no rain was experienced throughout the week. At Westminster the total was 0·01 inch, while at Greenwich there was no rain. Bright sunshine was in excess in all districts except Ireland N., where it was very slightly in defect. The English Channel was the sunniest district with 93 hours (83%), but the most sunny station was Hastings, 97·5 hours (86%). In contrast with this was the North-west of Scotland, where Glasgow reported 27·5 hours (23%), and Fort Augustus only 20·9 hours (17%). The temperature of the sea water ranged from 48° at Lerwick to 65° at Margate and Eastbourne.

The week ended July 15th was exceptionally fine and dry throughout. Temperature was above the average in all districts, by as much as 6°·0 in Ireland, S. The highest readings were 89° at Crieff, and 88° at Balmoral, Cullompton and in Ireland, S. The minima varied greatly. In the English Channel the lowest reading was 54° at Scilly, giving a range of temperature for the week at this station of 21°, while at West Linton the minimum was 35° and the range for the week 49°. At Durham, Alnwick and Llangammarch readings of 36° were recorded. On the grass still lower temperatures were observed, the lowest being 23° at Llangammarch and 29° at Crathes.

The rainfall was unusually slight; indeed over the greater part of the kingdom the week was rainless. The largest amounts reported were 0·35 inches at Gordon Castle, and 0·38 at Glencarron. Bright sunshine was greatly in excess in all districts, and at many stations it was double the usual amount. The sunniest stations were Newton Rigg, 100·4 hours (86%), Aspatria 100·2 hours (86%), and Bournemouth 99·9 hours (89%). At many other stations the total duration of sunshine exceeded 90 hours. Over the country generally the week was the finest experienced since the general establishment of sunshine recorders, in 1881.

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The temperature of the sea was higher than in the corresponding week of 1910, and the individual readings varied from 52° in Scotland to 67° at Margate, and 70° at Seafield.

During a kite ascent from Pyrton Hill on June 14th, the sky was overcast, but though the kite ascended to a height of over four thousand feet, the clouds were not reached. On this occasion the direction of the wind was found to be the same throughout, but its velocity steadily increased with the altitude. The humidity of the air also increased with the height from 70% at the ground to 95% at four thousand feet.

MICROSCOPY.

By A. W. SHEPPARD, F.R.M.S.,

with the assistance of the following microscopists:—

ARTHUR C. BANFIELD.
THE REV. E. W. BOWELL, M.A.
JAMES BURTON.
CHARLES H. CAFFYN.
ARTHUR EARLAND, F.R.M.S.
RICHARD T. LEWIS, F.R.M.S.
CHAS. F. ROUSSELET, F.R.M.S.
D. J. SCOURFIELD, F.Z.S., F.R.M.S.
C. D. SOAR, F.L.S., F.R.M.S.

HYDRACARINA OF CLARE ISLAND.—The Royal Irish Academy has just published part 39i of the Clare Island survey. This paper, to any one interested in the Hydracarina of the British area, will prove most valuable. The results of the survey will be published from time to time, as the different experts who have undertaken to work at their own particular group finish their reports. These reports will not only contain the flora and fauna of the island, but the history and geology of the district, and will be published in sixty-seven parts, four only of which are ready. Mr. J. N. Halbert, of the National Museum, Dublin, undertook, and has finished, the Hydracarina, and he has done it well. It is, I think, the best paper yet published on the water mites of the British area, both as regards the text and the figures. Mr. Halbert has added four new species to science: *Eylais relicta*, *Frontipoda Carpenteri*, *Atractides brevirostris* and *Unionicola rivularis*. Besides the above he has also added twelve species previously recorded on the continent only. Altogether, Mr. Halbert records eighty species, representing thirty-one genera, which, with the sixteen additional ones now added by Mr. Halbert, gives us two hundred and thirty species of Hydracarina, representing sixty-one genera, for the British area. *Hydrysphantes placationis* K. Thon, which Mr. Halbert asterisks as a new record, has been already recorded by Mr. W. Evans in 1909, for Scotland. See *Proceedings of the Royal Physical Society of Edinburgh*, Vol. XVII, page 42.

There is one mite Mr. Halbert mentions which I am not sure is correctly named on page 37; he mentions *Arrhenurus tricuspidator*, O. F. Müll., Achill Island, June. "The mite recorded here is the *A. bicuspidator* (Koenike) 12, and other references." Now Koenike, in 12, Acarina Milben Brauer, *Die Süsswasserfauna Deutschlands*, Heft, XII, 13-191, Figure 1, 277, 1909, gives both *A. tricuspidator* Müll. and *A. bicuspidator* Berlese, and there is no mistaking the two mites. The petiole of Müller's Figure Plate iii. Figure 2, in his Hydrachnae, 1781, is certainly rounded on the extreme posterior margin, but in Berlese's *A. bicuspidator* the margin of the petiole is curved inwards. I have both mites myself. What I take to be the real *A. tricuspidator* Müll. was recorded by Dr. George, for Britain, in 1901, as *A. maximus* Piersig, *Science Gossip*, 1901, page 230.

One of the most interesting finds is *Frontipoda carpenteri* Halb. as previous to this we only knew one species of this genus, *F. musculus* Müll. Another is the addition to the genus *Atractides*. Mr. Halbert gives a very useful synoptical table for the determination of species. There are three plates of well-drawn and well-produced figures, giving the absolutely essential details for identification of the species. Take it all round it is a most interesting addition to the bibliography of fresh-water mites.

CHAS. D. SOAR, F.L.S., F.R.M.S.

HYDRURUS FOETIDUS VILL.—Recently I had the good fortune to come across the above, and as it is in several respects a singular and interesting plant, it may be worth while bringing it forward in a short note. The first point about it is that it is decidedly rare in this country. Professor West says, "It is of very rare occurrence in the British Islands, being known only from Yorkshire and Scotland." But "it is common in central Europe and in the Arctic regions when the snows melt in spring." I found it in great abundance in a comparatively quiet backwater, in a rapid stream of ice-cold water running down towards the Mer de Glace, at Chamonix. It was attached to the rocks and stones, and was plentiful on a rock forming the edge of a small cascade. To the naked eye it looks like a dull-coloured moss, or one of the filamentous algae; the filaments attached at the base, floating free and swaying in the stream. Its specific name *foetidus* is appropriate, as it has a most unpleasant smell, resembling that of stale fish. The "Micrographic Dictionary" styles it "a genus of Confervoid algae" but at the same time points out its obviously true relationship, which is with the very simplest of the algae, the Palmellaceae. Probably there is not more than one species. Professor West calls it *Hydrurus foetidus*; Cooke, *H. penicellatus*, and mentions a variety. The filaments vary in size from quite small ones, up to a length of several inches. They are of considerable thickness, and simple at the base, while above they are densely branched, the branches often thickly covered with minute outgrowths and fibres, giving the whole a very moss-like appearance. Dr. Cooke has a drawing—"British Freshwater Algae," Plate 10 Figure 4—which exaggerates this a good deal, unless his illustration was taken from another variety. One would naturally expect the stem and branches to consist of cells with definite walls like other plants, but they do not. The whole is formed of a more or less tough gelatinous sticky substance, without any apparent structure under the microscope, and in this are embedded numerous minute olive-green bodies. They are packed closely and are somewhat globose in the branches, with a tendency to become mis-shapen and angular owing to pressure, while in the stem they become oval and elongated, or even comma-shaped, and are arranged partially in lines. They do not seem to have a definite wall; Dr. Cooke says it is difficult to distinguish one; Professor West says there is none. It is of course, these very small bodies that give rise to the gelatinous moss-like structure, and except for the peculiar form—a chance resemblance to that of a much more highly-developed organism — the relationship to such plants as *Tetraspora*, *Sphaerocystis* and *Palmodictyon*, which we find constantly in our own waters, would be evident. Professor West tells us "the entire structure behaves almost as a multicellular plant, growth in length being entirely dependent on single apical cells." He classes it with the Phaeophyceae, but its affinities seem to me much more with the simple genera named above, than with the highly-developed and specialized brown sea-weeds. Reproduction takes place by means of peculiar-shaped zoögonidia, developed from the coloured bodies in the branches. The filamentous form and minute branches and fibres are probably only an adaptation to the circumstances under which the plant exists. Were it not attached firmly to the rocks and stones, and of a form which gives only slight resistance to the stream, it would soon be washed away in the rapid torrents in which it dwells. Cold and violent mountain streams are not favourable dwelling places for most Algae; it is hardly worth while looking for them there, and this example is remarkable on that account as well as for its singular structure.

J. B.

THE MICROLOGIST.—We have received from Messrs. Flatters, Milborne and McKechnie, Ltd., the July number (Part V.), of their little quarterly journal, *The Micrologist*. As usual it is well illustrated, there being twelve text figures and three plates of figures reproduced in half tone. The first article is by Mr. Gordon A. McKechnie, and is devoted to the Porifera (sponges). A short account is given of their structure, classification and life-history, which is followed by details for the preparation of slides illustrating the histology of the different types. The slides, six in number, sent out with this part all illustrate sponge structure. Transverse sections of *Grantia compressa*, *Euspongia officinalis*, *Halichondria*

panacea, *Geodia gigas*, *Spongilla lacustris*, and the entire sponge (young) of *Leucosolenia botryoides*; this last slide shows the budding of a sponge. The section of *Grantia compressa* exhibits the collar-cells (*choanocytes*); the fresh-water sponge (*S. lacustris*) shows the "gemmules," vide page 59. The three plates referred to above illustrate Mr. Abraham Flatters' paper, which is devoted to the preparation of slides illustrating the histology of the wheat plant.

THE DWARF PLANKTON.—In connection with the short report in "KNOWLEDGE" (June, page 236) of my paper on "The Use of the Centrifuge in Pond-Life Work," read before the Quekett Microscopical Club in April last, I should like to call attention to a little pamphlet recently published by Professor H. Lohmann, of Kiel, entitled, "Ueber das Nannoplankton und die zentrifugierung kleinster Wasserproben zur Gewinnung desselben in lebendem zustande" (W. Klinkhardt, Leipzig, M. 1·50). The term *Nannoplankton* (νάννος = dwarf) has been coined by Lohmann for the extremely minute forms of life existing in water, the forms, in fact, which pass easily through the meshes of the finest silk gauze, and his paper is in the main a summary of the additional knowledge which has been gained about these organisms by the use of the centrifuge. The application of this instrument to the special purpose of collecting these very minute organisms is due to Lohmann, who was led to the conclusion that something supplemental to nets, or even filter papers was wanted as a means of collecting the smaller constituents of the plankton, by observing the rich and varied accumulations of tiny protists obtained by the extraordinarily fine filtering apparatus of some marine animals such as the Appendicularia. The method of centrifuging water in order to concentrate the contained "Nannoplankton" is undoubtedly a very powerful new means of research, and it can no longer be ignored by those interested in the life of our seas and fresh-waters. Very small quantities of water are sufficient as a rule (I often work with tubes holding only one-and-a-half cubic centimetres) and the bulk of the forms present are deposited in one or two minutes if the centrifuge be run at a fairly high speed, say two thousand to six thousand revolutions per minute. Practically no damage is done to the organisms during the process of centrifuging, and if examined immediately after, they will be found to be alive, so that even the most sensitive and fragile of the naked forms can be recognised. This, it need hardly be pointed out, is an utter impossibility with collections made by any straining method yet invented. The Nannoplankton is composed of bacteria, protophytes (schizophyceae, desmids, diatoms, chlorophyceae, phyto-flagellates), and protozoa (rhizopods and zoöflagellates), the bulk being usually formed by the phytoflagellates. The comparative volume of the Nannoplankton is small, but as Lohmann points out this does not prove that it is of no importance in the economy of the sea and fresh-waters. "The degree of importance in this respect depends essentially on the rapidity of the multiplication and the duration of life-time, as well as on the nutritive character of the organisms themselves. In this latter direction the Nannoplankton surpasses perhaps all the other Plankton and in the former respect it equals the other Protists at least. Should one wish to estimate the importance of the three chief groups of Plankton only according to their average life-time, one must place on a par one volume of Bacteria to about six volumes of Protists and to about three hundred volumes of Metazoa." For those who cannot read German there is an English summary appended to the paper, which is also accompanied by five plates of Nannoplankton organisms, drawn to scale, in frames representing a single opening in the silk gauze used for the finest Plankton nets.

D. J. SCOURFIELD, F.Z.S., F.R.M.S.

QUEKETT MICROSCOPICAL CLUB.—June 27th, 1911, Mr. C. F. Rousselet, F.R.M.S., Vice-President, in the chair. Mr. J. W. Ogilvy exhibited for Messrs. Leitz a recent invention, on the principle of the dark-ground illuminator, for rendering visible the particles in smoke and gases, and in liquids. Messrs. Watson exhibited a series of seven preparations, illustrating the development of the chick. The stages were twenty-four, thirty-two, forty, forty-eight, sixty, seventy-two and ninety-six hours of incubation.

A paper by Dr. E. Penard, on "Some Rhizopods from Sierra Leone" was read by Mr. Earland. The material examined was collected from a "slow, large river, containing weeds." Fourteen species had been found, of which three were new, and four at least might be considered as special forms or varieties. The genera represented were:—*Centropyxis*, two species; *Difflugia*, five species (two new); *Euglypha*, two species; *Lesquerentia*, three species (one new); and *Pontigulatia*, two species. The author expressed his indebtedness to Mr. G. H. Wailes for the material received and hoped that time and opportunity would be found for further investigations.

Mr. T. A. O'Donohoe read a note on "Dimorphism in the Spermatozoa of the Flea and the Blow Fly." Only about 70% of the specimens examined had the two forms noted, the minority having only the smaller form. The spermatozoa of the flea are very large compared with those of man, whose spermatozoa have an average length of about 0·06 millimetres. In the flea the larger form is 0·7 to 0·45 millimetres long, and the smaller form about half these lengths. Both are similar in structure and stain well with dilute carbol-fuchsin or gentian-violet. The two forms found in the Blow Fly are smaller than those of the flea. They do not differ much from each other in length, but one is very much thicker than the other. Photomicrographs of the specimens described were projected on the screen.

A paper by Mr. E. M. Nelson, F.R.M.S., on "Normal and Abnormal Vision in Microscopic work," was read by the Assistant Honorary Secretary. The experiments described showed the effects of long and short sight upon the magnifying power of the microscope. The differences are most marked with low powers. The author's sight being presbyopic, biconvex glasses are required to make it normal. When measuring the power of a microscope by means of a camera lucida, it is therefore necessary to use spectacles, otherwise, while the image of the micrometer in the microscope is sharp, that of the exterior scale, at ten inches distance, would be invisible to him. Experiment 1.—The power of a "loup" (focus about 1·6 inch) was measured, the spectacle lens being below the camera. The power was 6. Experiment 2.—As before, but with the spectacle lens above the camera; the power was 7. Experiment 3.—A double pair of spectacles of equal power were used; the presbyopic eye was therefore made myopic. A concave lens, which precisely neutralised one of the spectacles lenses, was placed below the camera. The "loup" now gave power 8. Experiment 2 shows the power of the "loup" with normal sight. The experiments on being repeated with a compound microscope giving six diameters showed similar results. It is generally understood that persons with short sight have wonderful powers of seeing minute objects, but few realize that anyone with three dioptres of myopia can with a six-power "loup" see as much as one having three dioptres of presbyopia with an eight-power "loup." Further experiments were also described.

ROYAL MICROSCOPICAL SOCIETY.—June 28th—Mr. H. L. Plimmer, F.R.S., President, in the chair.—Mr. Strachan: The structure of scales from *Thermobia domestica* Packard. The author showed that the longitudinal striae which appeared to project at the free margin of the scale were in reality the walls of a set of longitudinal tubes, and when pressure was applied to the scales the tubes might be made to collapse and disappear, and in some instances, when heat was applied, both fluid and air bubbles were observed to traverse the tubes. These tubes were on the convex side of the scales. Radial striae also crossed the longitudinal striae at various angles, and the author illustrated his paper by an ingenious model composed of two sets of parallel thin glass tubes in close contact, almost filled with fluid and sealed at the ends, one set containing oil of turpentine, the other ethyl alcohol. One set of tubes was fixed; the other set, placed in contact with them, could be rotated over a considerable angle. By illuminating

XUM

this model obliquely and varying the angle at which the tubes crossed, all the appearances of beaded, exclamation and cuneate markings observed in the natural scales could be exactly reproduced.—Mr. Murray: Further report on the rotifera collected by the Shackleton Antarctic Expedition of 1909. *Rotifera of New Zealand.* There were collected forty-one species of Bdelloids, and twenty-six species of other orders. Three new species were described—*Callidina microcornis*, *Rotifer curtipes* and *R. montanus*. A species of Pedalion (not identified) occurred as a plankton animal in a great lake (Wakatipu). The Bdelloid fauna of New Zealand appeared to be poor, considering the variety of conditions found in different regions. *Rotifera of S. Africa.* During a short stay at Cape Town nine Bdelloids were collected on the lower part of Table Mountain. There was one new species, *Dissotrocha pectinata*, related to *D. spinosa*. This small collection was noticeable for the absence of any of the species characteristic of tropical and subtropical Africa, many of which occurred in other parts of Cape Colony.

Mr. Conrad Beck gave a demonstration of the method of determining in wave-lengths the divisions of a stage-micrometer by means of an interferometer.

He said the interferometer consists of a series of mirrors which receive a beam of light from a radiant source, and divide it into two beams of light, which are afterwards re-combined and viewed by a telescope. All the portions of the instrument are fixed, except one reflecting mirror, which reflects one-half of the divided beam of light. This can be set in such a position that the two half-beams of light, during their period of division and before they re-combined into one, have travelled exactly the same distance. A movement of the reflecting mirror can then be made, so that one half-beam of light has travelled half a wave-length farther than the other; and when that is the case, interference will take place, and the light will be extinguished. As the mirror is moved farther, the light will again appear, until the path is one-and-a-half wave-lengths different, when a second interference is produced; this goes on at each successive motion of the mirror through the same distance, and the wave-lengths are counted.

As a matter of practice, it will be seen, on looking through the telescope, that the effect is not a complete change from brightness to darkness, because this only takes place in the exact centre of the field, and a series of bright and dark bands are seen in the field, which travel from right to left, and are counted as they cross the centre of the field against a line in the telescope.

The apparatus was shown with a Bunsen burner and a sodium flame as being a sufficiently monochromatic light for demonstration; but as the sodium light is not a purely monochromatic light, but consists of two lines which are not in themselves quite monochromatic, sodium does not form a very good source for the illumination. Either cadmium, mercury or hydrogen, used in connexion with a prism which shall direct one only of the chief lines into the instrument, is the best for the purpose.

The micrometer is held on a bracket which projects out from the carriage on which the moving mirror is fixed in such a manner that, although it is viewed by the microscope, it is not in contact with it, and no friction is caused which could interfere with its motion.

Mr. Conrad Beck exhibited a new portable microscope suggested by Mr. Murray. He said that this instrument had been designed to meet the wishes of Mr. James Murray, the well-known explorer, who was anxious to have a microscope extremely small and portable, and which could be used in the field. Being away from the comforts of civilization, in tropical forests, he would be debarred from the luxury of chairs and tables, and the microscope was therefore so designed that it had one leg, which could be strapped to a walking-stick, which had been driven into the ground, and the observer could sit with the stick projecting from the ground between his legs, and the microscope could be inclined by means of the usual joint to a convenient position. The instrument was on the model of the Star Microscope, with an aluminium stage, and all the superfluous metal removed to make it extra light. It had a sliding coarse-adjustment, a micrometer-screw fine-adjustment, and a small substage condenser, with iris diaphragm. It was provided with two loose legs, which screwed into the single leg-base, making it into a tripod for use on a table in the usual way, when such a support was available on the return from an expedition. For the study of pond-life on the spot this instrument was especially desirable, as the naturalist on the walking-ing-stick-stand principle might spend many profitable hours in pleasant weather in conducting his microscopical examination at the side of the pond, or on the country-side in the open air.

Mr. Murray remarked that as the journey he was about to undertake had to be made without the assistance of carriers, it became important to reduce the weight to the utmost, because every ounce put into instruments to be taken must be deducted from the amount of food which could be carried. Therefore, remembering his previous experience with the Star Microscope on his journeys, he asked Mr. Beck if he could improve upon that instrument in the matter of weight. The present microscope was the result. It was true that the necessity for unscrewing the legs of the tripod introduced a structural weakness, but the instrument was intended to be primarily used on a walking stick. Its use in the ordinary way, on a table, was a secondary matter. It was not anticipated that one would be able, as Mr. Beck had said, to sit comfortably and work with the microscope; that was usually impossible in the Amazonian forest. It was proposed to have the walking-stick sufficiently long to enable the observer to work standing. Quite possibly the conditions would prevent work, but it was hoped sometimes to rig up a net to keep out insects and allow a little work to be done. Mr. Beck had not stated what the weight of the microscope was. Complete in its case, as fitted for use on the table, it weighed two pounds. But even that was far too much to take on such a journey; for, as he had said, only so much could be taken, and the heavier the instruments, the less the quantity of food which could be carried. Therefore, when the difficult journey began, the case of the microscope would be left behind, the two supplementary legs would be unscrewed, and the microscope folded up and wrapped in a spare shirt. The weight, without the case, was only one pound.

BOTRYDIUM GRANULATUM (L.)—The water at the Welsh Harp reservoir, Hendon, is very low, and it may be of interest to some to know that large stretches of mud are at present—July 20th—in many places covered with the singular little plant *Botrydium granulatum*. It is not so plentiful as it was last year, vide *Journal of the Quekett Microscopical Club*, Ser. 2, Vol. XI., No. 68, page 209, probably because, with the drought and great heat, the mud is dried too quickly for the plant to develop. *Botrydium* does not seem very common in the London district, but here it covers an immense area.

J. B.

ORNITHOLOGY.

By HUGH BOYD WATT, M.B.O.U.

DISTRIBUTION OF THE NIGHTINGALE IN GREAT BRITAIN—FIRST OCCURRENCE IN SCOTLAND.—Commenting on the note in our last number (page 282) a correspondent writes as follows:—"It appears to me that the whole body of evidence collected by Messrs. Ticehurst and Jourdain wants to be rearranged with respect to its salient features; restated to show the value or valuelessness of its component parts; and, generally, to be dealt with in as broad, critical, and philosophical a spirit as can be brought to bear upon it. I am pleased that the information has been brought together; more than that I cannot say, unless that I am dissatisfied with the want of any adequate examination of it by the authors of the paper."

Our correspondent (who writes from Scotland) further remarks that the physical difficulty of extension was overcome when the Nightingale had reached the valleys of the Dee, Weaver, and Mersey in Cheshire, and that there was consequently nothing physical to prevent extension into Lancashire; also that if the species had been in Yorkshire

and Lincolnshire for a century there was nothing to hinder it following the coast line to Scotland.

These observations have received immediate point by the publication in the new number of the *Annals of Scottish Natural History* (No. 79, July, 1911, page 132) of a short paper by Misses E. V. Baxter and L. J. Rintoul announcing that they had secured a single specimen of the Nightingale on the Isle of May, Firth of Forth, on 9th May, 1911. This is an addition to the avi-fauna of Scotland, and to the rarities and valuable records which careful and continuous watching of the Isle of May has yielded to the writers above-named. Following recent nomenclature they call the bird the Southern Nightingale (*Luscinia megarhynchos megarhynchos* = *Daulias luscinia* of Saunders and other authors).

[Our readers are invited to send in any observations that they may be able to make upon the distribution of the Nightingale.]

ARE BLACK GAME VERMIN?—The answer to this question, like many others, depends largely upon the point of view and upon personal predilections, and sportsmen may probably not agree with the judgment given in the recently published "Forest Survey of Glen Mor" (1911), by Lord Lovat and Captain Stirling of Keir. This work contains recommendations for the treatment of grouse and low game shooting from the point of view of the forester and timber-grower, and makes the proposal to reduce Black Game from the status of game birds to that of forest vermin. With this finding, all who have had experience of the depredations of the species will, we believe, be found ready to agree, with but little reluctance.

BIRDS BREEDING IN THE LONDON ZOÖLOGICAL GARDENS.—This has been a good season and about one hundred and fifty had already bred by the beginning of July, although, for foreign species, the season was not more than half over then. The expectations and prospects were that this number would be considerably augmented. The Wigeon does not commonly breed in confinement, but of this native British species there were fifteen well-grown ducklings, and another brood was looked for. Amongst the young Gulls were three interesting hybrids, the produce of the Lesser Black-Backed and the Common Gull.

ABUNDANCE OF THE COMMON SWIFT (*CYPSELUS APUS*).—It is far from easy to compare the numbers of any of our commonly seen birds, season with season, with any approach to accuracy. In any summer the Common Swift is an abundant bird in the neighbourhood of London, but this year it seems to be present in larger numbers than usual, judging by the swarms which are now disporting themselves in the district on the Middlesex and Hertfordshire borders. In the neighbourhood of Bushey, for instance, a glance around any morning or evening shows some dozens within sight in the air. To attempt to estimate the numbers would be futile; but it may be worth remarking that, one day in the month of May three years ago, 1908, the writer spent a considerable time in attempting to count the numbers of a large gathering of Swifts, hawking over the surface of the Brent Reservoir, Middlesex, and approximately set them down as some seven hundred or eight hundred birds.

BIRDS IN THE ELEVENTH EDITION OF THE "ENCYCLOPAEDIA BRITANNICA" (1911).—This work contains reprints of the series of articles contributed by the late Professor A. Newton to the ninth edition with some small alterations. These articles are assuredly classics in ornithological literature, but it is to be regretted that the new edition does not contain the supplementary matter which Professor Newton himself included in republishing them in his great "Dictionary of Birds" (1893-6). This leaves the last-named work, and not the new edition of the "Encyclopaedia" as the final and more complete authority on the birds included. The "Encyclopaedia," however, contains fresh ornithological writings in such articles as those on the general subject "Bird," and on "Egg," "Feather," and so on.

PHOTOGRAPHY.

By C. E. KENNETH MEES, D.Sc.

TRI-COLOR PRINTING INKS.—To the *Process Photogram* for July, Mr. A. J. Bull contributes an excellent article on the rendering of greens in three-colour work, in which he directs attention to the fact that the difficulties met in reproducing greens by the three-colour process, are mainly due to the fact that even the best blue inks used for that process have but a low reflecting power for green light. In a totally different article, that by Sir Harry Johnston on the art of painting, in the *Westminster Gazette*, we find another indictment of three-colour printing inks from the point of view of the artist. He writes:—"Fortunately for painters, a stereotyped reproduction in colour is hampered at the present day by the miserable quality of the inks and pigments used by all colour printers (except here and there in Germany, Austria, and France)." This would seem to imply that Sir Harry Johnston considers that the printers are to blame for the poor quality of the inks and pigments that they select, but it would be interesting to know on what grounds he makes exception in favour of certain printers in Germany, Austria, and France. It may be true that there are printers in those countries who produce better results than those produced in England or the United States,—the present writer does not possess the necessary knowledge to give an opinion upon the subject, but he doubts very gravely whether, if the results produced are superior, the effect is to be ascribed to the use of better inks. Colour-printing inks are chiefly made in large quantities by big firms, and any ink that is on the market can be obtained by any printer who desires it, nor does the price of an ink necessarily increase with its suitability for three-colour work.

The real difficulty in the obtaining of more suitable inks for the three-colour process lies in the wide separation between the user of the inks and the original producer of the colour. The user of the ink is the printer, but the colour is largely chosen for him by the photo-engraver who makes the blocks, and he, in his turn, is limited by the inks that he can obtain from the maker, who is again limited by the lakes which the dye works can supply. It is not to be expected that these various commercial undertakings will all fully understand the theory of the three-colour process, the only one of them who actually requires the knowledge in every-day work being the block-maker, and hence, while most photo-engravers now understand what inks they require, ink makers, as a rule, will tell you frankly that they supply any colour of ink for which they can obtain satisfactory lakes, and leave the choice of the inks to the engraver. A visit some years ago to a great dye works containing a section devoted to the preparation of lakes for three-colour printing opened the writer's eyes to the fact that the scientific chemists in charge of that section, had not the least knowledge of the theory of the three-colour process, and had not taken any steps to attempt to obtain permanent colours of the right shade, the colours which the firm recommended for the production of three-colour printing inks being entirely unsuited to the purpose, and being selected simply for their printing qualities, with very little reference to theoretical requirements as to colour. It is not too much to say that there are no inks in existence which are both permanent and of the right shade for three-colour printing, and the reason for this is undoubtedly that the dye works have not yet produced permanent lakes of the right shade. There is, of course, no difficulty with the yellow ink, but the red ink always reflects far too little blue, while the blue ink reflects only a small proportion of the required amount of green. There are dyes which are nearly of the right shade: some of the acid rhodamines, for instance, are nearly the right shade of magenta, and fast green blue shade, or patent blue would make a satisfactory blue ink, but apparently the lakes which can be produced from these dyes are not fast to light, so that for improvement in colour-printing, as in so many other things, we must look to the scientific chemist at the base rather than to the ink-maker or printer who are dependent upon him for their materials.

THE DEVELOPMENT OF QUANTITIES OF NEGATIVES.—When a large number of exposed

plates have accumulated one's thoughts turn to methods of handling a larger number of plates at the same time than would usually be employed and the ease with which several plates can be developed in a tank is certainly one reason for the popularity of tank development. Tank development, however, introduces a number of possible difficulties which are less likely to occur during development in a dish. In the first place a tank should be selected which can be reversed or shaken so that circulation of the developer can be assured, because otherwise there is considerable danger of accumulations of oxydised developer which may produce most unexpected marks upon the plate. A photograph of a church tower against the sky, for instance, which is left quiescent in a tank with the sky downwards may show upon the prints a white mark extending up into the sky from the tower. This is owing to the fact that the developer on the face of the plate immediately over the tower does no work, and consequently remains fresher than the developer covering the rest of the sky, and this fresh developer slowly streaming over the sky immediately below the tower produces a streak of greater density in the negative, which appears light in the print.

If a very dilute developer is used for prolonged development, generally known as "stand" development, marks of obscure origin are often met with and such a developer may give rise to a considerable amount of general fog. The reason for this fogging by dilute developers has not hitherto been understood, but some recent observations would appear to show that in some cases, at any rate, it is due to the lowering of the sulphite concentration in the developer, and may be removed by addition of sulphite when the developer is diluted. A difficulty with many developers when used for stand development, is that it is impossible to calculate the time of development from the dilution, because the reducer is oxidised by the air dissolved in the water used. The dilution of one part of a metol developer, for instance, with nine parts of water, will not give a developer requiring ten times as long for development as the original solution, but a longer period will be required, the extension depending upon the air content of the water used for dilution. A reducer, which appears to be almost entirely free from this defect, and which, therefore, must be little amenable to aërial oxidation, is glycin, which is peculiarly suitable for timed development with weak solutions.

PHYSICS.

FRESH SUPPORT FOR PROFESSOR BICKERTON'S THEORY.—The conclusions of Professor Kapteyn's recent address to the Dutch Science Congress, based on his own and other observations, furnish a most remarkable case of the fulfilment of physical deductions and predictions.

For over thirty years Professor Bickerton, of New Zealand, has with increasing emphasis been making cosmic dynamical deductions and publishing papers and books, showing that every characteristic of our Galaxy can be most easily explained by assuming that it is made up of two cosmic systems, of different orders of development. Ages ago these two systems interpenetrated one another, coalesced, and swung off the double spiral of stars called the Milky Way. The idea was very clearly shown in a paper in the *Philosophical Magazine* for August, 1900. Kapteyn's conclusions are as follows:—

"The Stellar system was not originally a single system in which the two known drifts or currents have developed; but the present system is the result of the encounter of two systems which originally were entirely independent of each other."

"The primordial matter is now more abundant in the drift of less star-density, and is almost entirely absent from the opposite drift which is richer in stars."

Kapteyn's system of much primordial matter is Professor Bickerton's cosmic system of the first order, which on dynamical grounds he shows must grow up in the empty parts of space. One of these primordial systems has interpenetrated with one of a higher order. Such impacts, to quote Professor Bickerton's paper in the *Philosophical Magazine*, will produce a cosmic system of a third order, of which our Galactic system is a type.

For some years back, in Australasia, there has been growing up a belief that this new cosmogony is true, as it has anticipated in a remarkable way so many subsequent discoveries. This belief has culminated in the New Zealand Government sending Professor Bickerton to England to present it as a working hypothesis to guide astronomical research.

In our next number Professor Bickerton will tell the story of Nova Persei, the new star of the new century, that in less than two days grew from invisibility, to be actually the brightest star in the Northern Hemisphere. Had the flash of this temporary star been seen at the same distance as our Sun, this huge celestial light would have been ten thousand times as bright a blaze as the Sun itself. Professor Bickerton says that all new stars are the explosively hot third bodies, torn from grazing suns. The surprising number of phenomena that were scientifically deduced, as possessed by this vast cosmic spark, a score of years before Nova Persei appeared, and the complete way all have been demonstrated by astronomers, reads more like a fairy tale than a statement of sober fact.

SEISMOLOGY.

A SEISMOGRAPH AT A LONDON EXHIBITION.—At the Coronation Exhibition, Shepherds Bush, there is this year one very interesting sight—a seismograph actually at work. The exhibitor is Mr. J. J. Shaw, of West Bromwich, and he believes that this is the first time that a seismograph has ever been publicly exhibited under working conditions. He has been fortunate in that, during June, two large earthquakes occurred and were recorded by his instrument.

Mr. Shaw's instrument differs in several details from Professor Milne's well known pattern which has been adopted as the standard form by the Seismological Section of the British Association. The two horizontal pendulums are suspended from separate brick columns and actuate multiplying levers which by means of glass needles record the movements on a smoked paper roll carried on a revolving drum. These two records are marked side by side with the time record between them. This is, for popular demonstration purposes, a method superior to that adopted by Professor Milne, whose instruments give photographic records which require to be developed before they become visible.

A record on the Seismograph, at the exhibition, of an earthquake in Mexico on June 5th, is only the second that has been made on any instrument in London.

ZOÖLOGY.

THE FLYING APPARATUS OF THE BLOWFLY.—Dr. Wolfgang Ritter describes in *Smithsonian Miscellaneous Collections*, Volume 56, No. 12, his researches upon the flight of an insect. He finds that the downward movement of the wings is caused by the contraction of two powerful dorsal muscles, and he has repeated an old experiment illustrating this. From a recently-killed fly, whose wings are raised, the abdomen and head are removed and the thorax grasped with a broad pair of forceps, so that one part of the latter is at its anterior, and the other at its posterior end. On compressing the forceps the thorax is shortened just as it is when the dorsal muscle contracts and the wings descend. The dorsi-ventral muscles act as antagonists to the dorsal, and by compressing the thorax in a vertical direction, raise the wings. A direct muscle brings the wings back from the position of flight to that of rest. Other direct muscles, which probably act as steerers, draw the wings respectively forward and backward and depress various portions of it.

THE SPIRIT BUILDINGS AT THE BRITISH MUSEUM (Natural History).—It has been announced that an amicable settlement has been arrived at between the Trustees of the British Museum and the Office of Works with regard to the site for the Science Museum, for which the ground now occupied by the Spirit Building, with its important collections of zoölogical specimens in alcohol, was demanded. No further official information is forthcoming, but it is said that the arrangements that have been made will obviate the necessity of pulling down the building in question.

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FLIGHTLESS BIRDS.

By MATTHEW DAVENPORT HILL, M.A., F.Z.S.

THE power of flight is undoubtedly one of the most marked characteristics of birds. Yet we know that time and again birds belonging to widely different orders have lost it, accompanied to a greater or less extent by atrophy of the wings and pectoral arch. It is interesting to consider, as far as possible, what

FIGURE 1.
Hesperornis regalis Marsh (restored) from the Cretaceous of North America.

changes in environment may have brought about such striking modifications. Although the absence of enemies, and abundance of food close at hand may suggest reasons for the loss of flight in such birds as the Kiwi and Owl Parrot of New Zealand, yet it is probable that here, as elsewhere, the law of correlation of structures, about which at present we know so little, has played a part in the transformation, coupled with a change in the habits and circumstances of the ancestors of flightless birds. For there can be little doubt that the reptilian forerunners of birds generally were terrestrial, and probably arboreal, animals, not aquatic, as some writers have suggested. In any case the pterodactyles cannot be regarded as being in the direct line of descent of birds.

Archaeopteryx lithographica, the most ancient, as well as the most primitive bird, "created," as Huxley said, "to prove the truth of the theory of evolution," had well-developed fore-limbs, even if they were not very serviceable wings, and hence we may assume that in all cases flightless birds have descended from flying ancestors. Bearing this in mind, it is certainly remarkable that one of the most ancient known birds, *Hesperornis* (see Figure 1). found in the Cretaceous shales of Kansas, had lost the power of flight completely. In fact the wing-bones were absent, and the breast-bones and pectoral arch much reduced. The bird was a gigantic diver,

FIGURE 2.
Phororhacos longissimus Ameghino (restored) from the Santa Cruz Bed (? Miocene) Patagonia.

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FIGURE 3.
Aepyornis maximus Geoffroy (restored) from the Pleistocene of Madagascar.

allied to the grebes of to-day, so well adapted to an aquatic habitat that it probably rarely, if ever, walked on land. The set-back of the legs, and the large knee-cap and enemial crest seem to have rendered an erect position impossible. The mouth was well provided with teeth, set like a lizard's in a groove, not in distinct sockets. The remains of other Mesozoic birds have been found which, barring the possession of teeth, are not very different from modern forms, *e.g.*, *Icthyornis* allied to the gulls.

Unfortunately for the palaeontologist the bones of birds are rarely found fossilized. Their lightness prevents them in a great measure from sinking, and thus being covered up by some sedimentary deposit, a necessary step in the process of fossilization. Hence it is not hard to understand why, with the important exception of *Archaeopteryx*, as yet no remains of any intermediate forms between reptiles and birds have come to light.

In the Santa Cruz Bed (? Miocene) of South America we find the remains of another giant flightless bird *Phororhacos*, allied probably to the Secretary Bird of South Africa. The reason for the large size of many flightless birds is not hard to see. Among the extinct pterodactyles, as well as in birds, there is a strict limit to size when the body has to be raised into the air. Muscular tissue and general vertebrate anatomy being what it is, we may safely assume that no animal much larger than a swan ever flew through the atmosphere of our planet. But as soon as the necessity for flight is removed, so likewise is the embargo on any increase in size, and natural selection has a free hand. Size, strength, and fleetness of foot have often to make up for loss of flight. A few generations, probably, were sufficient to produce a marked increase in weight and stature in a bird that had ceased to fly. To return to *Phororhacos*. The bird had certainly a larger and more massive head and beak than any other yet discovered, and it is not improbable that it resembled Figure 2. It is portrayed killing a lizard, but there can be little doubt that it would have made short work of any living snake if its habits and mode of attack were the same as those of its smaller modern relative.

Figures 3 and 4 are those of *Aepyornis* and

FIGURE 4.
Dinornis maximus Owen (restored) from the Sand-hills of New Zealand.

Dinornis (the Moa). The first of these—the eggs and remains of which have been found in Madagascar — is generally believed to be the original of the "Roc," and certainly lived down almost to historic times. It was a flightless, ostrich-like bird that laid one enormous egg at a time. Specimens have been found measuring 13 inches by 9·5 inches. In this connection it is interesting to note that the *Apteryx*, a modern flightless bird of New Zealand, about the size of a fowl, lays, likewise, an egg entirely out of proportion to its bulk, being very nearly as big as that of a swan. Doubtless in flying birds the eggs are necessarily prevented from becoming very large, to ensure that the bird does not become too heavy, but in those that are flightless there is no such need.

(To be continued.)

THE TIME OF HIGH WATER.

By J. A. HARDCASTLE.

AT this time of the year so many people enjoy the sands and the bathing at the seaside, that the time of High and Low Water is a subject of considerable importance, and the wise man will consult a local tide-table if he wishes to choose the best date for his visit or indeed the best seaside resort for his purpose. The Norfolk coast has long enjoyed a great popularity, yet it is more than probable that no one has noticed one great advantage that it possesses, a feature, the loss of which would be more detrimental than the disappearance of the much-vaunted sands. It consists in the particular value for that coast of what is technically called the "establishment," a list of which quantities is given in *Whitaker's Almanac* page 68. The value for Cromer is five hours—meaning that High Water occurs there five hours after High Water at London Bridge.

It is common knowledge that each day the tides occur fifty minutes later, and consequently, in the course of fourteen days they go all round the clock, and the moon also passes from new to full and full to new in fourteen days. Consequently if High Water occurs at noon on the day of new moon it will occur at noon also on the day of full, and in fact all the Spring Tides will be high at noon. It is also well known that the tides proceed round the coast and on any one day High Water occurs at a different moment at different ports. Thus, for instance, Spring Tides are high at Aberdeen at 2 o'clock, at Cromer at 8 o'clock, at Brighton at 12; these hours may be taken as both morning and afternoon since there are practically twelve hours between any two high tides.

I can well remember my disappointment as a child at hearing again and again of wonderful high tides beating on the sea-wall at Cromer, but they always happened when I was in bed because the Cromer Spring high tides occur at 8 o'clock; but then on the other hand the Spring low water laid bare the best sands and sometimes even showed us the old Church Rock, and these low waters always occurred in the middle of the day. This then is the first point of advantage conferred by the "establishment"; the lowest tides and the best sands happen in the middle of the day. Now at Ramsgate the "establishment" differs from that of Cromer by seven hours and so the Spring flood-tide is in the middle of the day and the best of the sands are bare at 7 a.m. and 7 p.m., which is far less convenient.

It will, however, be urged that the loss of that particular low tide to the visitor who stays a fortnight is not serious. A week later Cromer will be having low water at 7 or 8 o'clock and Ramsgate at about noon, and though those will indeed be Neap Tides, the difference scarcely matters much.

But that rejoinder betrays ignorance of one of the most interesting features in the run of the tides, which is called their priming and lagging.

The following Table gives the times of High Water at Cromer for September and October, 1911; the first column being drawn up on the assumption of a uniform interval of fifty minutes from day to day, the second gives the actual time of High Water—while the third gives the actual intervals.

TIDE TABLE FOR CROMER.

1911.		At uniform intervals.		At true intervals.		
Sept. 21		5.46 a.m.	...	5.46 a.m.		
,, 22	New Moon	6.36	...	6.34	48	C
,, 23		7.26	...	7.13	39	C
,, 24	Springs	8.16	...	7.48	35	C
,, 25		9.6	...	8.22	34	C
,, 26		9.56	...	8.57	35	C
,, 27		10.46	...	9.28	31	C
,, 28		11.36	...	9.58	30	C
,, 29		12.26	...	10.32	34	
,, 30	1st Qr.	1.16	...	11.12	40	
Oct. 1		2.6	...	12.6	54	I
,, 2	Neaps	2.56	...	1.19	73	I
,, 3		3.46	...	2.58	99	I
,, 4		4.36	...	4.23	85	
,, 5		5.26	...	5.21	58	
,, 6		6.16	...	5.59	38	
,, 7		7.6	...	6.35	36	C
,, 8		7.56	...	7.7	32	C
,, 9		8.46	...	7.39	32	C
,, 10		9.36	...	8.15	36	C
,, 11		10.26	...	8.50	45	C

Let us suppose that the most convenient hour for the summer visitor to have low water is between 12 and 4, while the most inconvenient is between 6 and 10. Our Table gives High Water so we must state it thus:—

Convenient days High Water from 6 to 10.
Inconvenient days High Water from 12 to 4.

I have marked with a C and an I these days respectively—and one sees at once that there are seven convenient days and only three inconvenient days, while five days are indifferent. After fifteen days everything repeats itself. The reason is apparent by reference to the third column. Spring tides occur two days after new and full moon, for certain reasons that need not now concern us, and for three or four days before and after the Springs the tidal intervals are very short; the tides are said to be priming. On the other hand at Neaps the tides lag and the intervals are long.

If, therefore, the "establishment" is such that Spring tides occur at a favourable hour in the day—you will get perhaps seven very favourable days to three unfavourable—or roughly speaking it is two to one in favour of the tripper finding the sands convenient for him at Cromer. At Brighton it is precisely the opposite, seven unfavourable to three favourable days.

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REVIEWS.

ARCHAEOLOGY.

The Past at our Doors: Or The Old in the New around us. By WALTER W. SKEAT, M.A. 198 pages. 52 illustrations. 4¾-in. × 7-in.

(Macmillan & Co. Price 1/6.)

The second title of this book gives perhaps the better idea of its contents for they deal with the story of our food, our dress and of our home. To a great extent the origin and use of the names comes in for attention, but those who like to trace the history of the things around them from the small vestiges and peculiarities which survive, will be charmed with the book.

We learn the meaning of the dairy where bread was originally kneaded; a hamper was once a basket to hold a particular kind of drinking cup; the hearse took its name from a framework of spikes like a harrow on which to stick candles, and for that reason was given the same name as a harrow. Even in connection with the story of our home, trade signs are considered, while the subject of clothes is one that is always attractive.

BACTERIOLOGY.

Aids to Bacteriology.—By C. G. MOOR, M.A. 240 pages. 4¼-in. × 6½-in.

(Baillière, Tindall & Cox. Price 3/6 net.)

This little book, of which we welcome a second edition, contains many useful hints both for those who are not familiar with bacteriology and those who are working at the science and want to find, easily, details as to methods of preparation, staining, collection of samples, and the general points to be borne in mind with regard to various diseases which are due to bacteria.

BIOLOGY.

The Biology of the Seasons.—By J. ARTHUR THOMSON. 384 pages. 12 coloured illustrations. 5½-in. × 8¾-in.

(Andrew Melrose. Price 10/6 net.)

Professor Thomson's book is full of interest, because, not only does he give us facts and put them before us in his own way, but because he discusses theories and reminds us that there are still differences of opinion in many biological matters. As the name implies, the treatment in the book is seasonal, following that natural but informal sequence, which is one of the great advantages of what is known as nature study, which is scientific but not science. As may be expected, birds come in for a good share of attention, the meaning of their song for instance is discussed and the question whether they learn to build their nests or instinctively construct them is considered.

We may mention also the chapter on the migration of eels, and most particularly that dealing with adolescence. The book is illustrated by a number of reproductions of coloured sketches, which are certainly a change from the photographs from which most popular books are now illustrated, but they are mounted on paper which is so dark that it detracts from their effect.

We should like to see "The Biology of the Seasons" very widely read.

BOTANY.

Life Histories of Familiar Plants.—By JOHN J. WARD. 204 pages. 120 illustrations. 5-in. × 7¼-in.

(Cassell & Co. Price 3/6.)

In natural history familiarity is far from breeding contempt, and there is so much to learn about even the commonest creatures, that it would be strange if Mr. Ward's book had not proved successful, as the call for a popular edition shows it to have been. The photographs are exceedingly good, and reproduced plainly and simply without any of the flummery or inartistic combinations which occur in many nature books.

CHEMISTRY.

Chemistry for Matriculation. — By G. H. BAILEY, D.Sc. Ph.D. and H. W. BAUSOR, M.A. 548 pages. 110 illustrations. 7-in. × 5-in.

(University Tutorial Press. Price 5/6.)

This book, as its title suggests, is intended to help students across the pitfalls of the Matriculation Examination of the University of London. It is divided into four sections, viz.:—I, dealing with the general principles of Chemistry; II, with the non-metals; III, with the more common metals and including a chapter on electrolysis; and IV, with chemical calculations.

Since the pass-list is the ultimate aim of the book, its contents are of necessity rigorously compressed and all extraneous matter is excluded, but the experiments are so well chosen as to remedy to a large extent the usual bad effects of such compression. The ground required for the examination is certainly most efficiently covered, and even students who are not working under the shadow of examination will find the book of use to crystallise their knowledge.

C. A. M.

The Chemistry and Testing of Cement.—By C. H. DESCH, D.Sc. 267 + x. pages. 9 plates. 5½-in. × 8½-in.

(Edward Arnold. Price 10/6 net.)

Dr. Desch's book is of interest to the scientific chemist mainly, owing to its able discussion of the chemistry of the setting of cement.

In confining himself to the scientific side of the question, Dr. Desch, in his book on "The Chemistry and Testing of Cement," has filled an hitherto conspicuous gap in the ranks of modern cement literature. There are many excellent works dealing with the practical aspect of the industry, but none of these deal in an exhaustive manner with the questions so efficiently discussed by Dr. Desch.

The author has gathered the results of researches dating from the time of Le Chaletier to the present day, and presented them to his readers in a concise and masterly fashion. The subject is thus shewn to be a fascinating one, and there are still many opportunities for further research. The work under review indicates the lines along which future work must proceed.

On experimental grounds the author finds himself unable to accept the crystalline theory of setting advanced by Le Chatelier. This theory supposes the setting of the cement to be due to the interlocking of crystals of hydrated silicates of calcium. Dr. Desch considers the experimental evidence in support of this view to be insufficient. Microscopical examination of a hardened cement, according to the author's own researches, does not reveal the presence of a sufficient proportion of crystalline constituent. By far the larger proportion of the constituents appear to be amorphous. From this, Dr. Desch is led to support the views of W. Michaëlis, who suggested, so far back as 1893, that "the calcareous hydraulic cements owe their hardening mainly to the formation of colloidal calcium hydro-silicate."

Dr. Desch says: "The theory (of Michaëlis) so well explains the phenomena observed, and is in such good accordance with the results of microscopical investigation of cements during and after setting, that it must be held to contain at least a greater part of the truth."

The hardening of cement Dr. Desch considers to be due to the loss of water experienced by the colloidal bodies formed.

Many interesting experimental data are given.

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The mechanical and physical properties, their determination, and the mechanical analysis of cement, also receive careful attention.

The book may be represented as containing the most modern accepted views of the chemistry of cement, and is a highly important and successful addition to existing literature on the subject. It should find a place in the library of every scientific chemist.

W. A. B. W.

Modern Industrial Chemistry.—From the German of H. BLÜCHER, translated by J. P. MILLINGTON, M.A. 779 pages. 6½-in.×9½-in.

(The Gresham Publishing Company. Price 30/- net.)

This volume is really a chemical dictionary. Reference to a number of the items considered in its pages shows that the information contained in it is full, considering the amount of space there is to spare, and we have no hesitation in saying that it will prove most useful, not only to chemists but also to the mass of educated persons who often wish to know more about some substance or process of which they hear or read.

MATHEMATICS.

Orders of Infinity: the Infinitärcalcül of Paul du Bois-Reymond.—By G. H. HARDY, M.A., F.R.S. 62 pages. 8¾-in.×5⅜-in.

(Cambridge University Press. Price 2/6 net.)

This work forms No. 12 of the valuable series of short mathematical tracts entitled "The Cambridge Tracts in Mathematics and Mathematical Physics," published under the general editorship of Messrs. J. G. Leathem, M.A., and E. T. Whittaker, M.A., F.R.S.

As Mr. Hardy remarks in his preface, "with the particular system of notation that Du Bois-Reymond invented, it is, no doubt, quite possible to dispense; but it can hardly be denied that the notation is exceedingly useful, being clear, concise, and expressive in a high degree"; and mathematicians in this country will, no doubt, be grateful to Mr. Hardy for presenting them with Du Bois-Reymond's valuable ideas in an English dress. Du Bois-Reymond, unfortunately, is at times highly obscure, and many of his proofs can hardly be regarded as conclusive. Mathematicians have further to thank Mr. Hardy for largely remedying these defects, and for bringing the "Infinitärcalcül" up-to-date. It is rather a pity that lack of space has prevented him from discussing the various points that arise in the book rather more fully than is done; and it would certainly have been an addition welcomed by readers whose mathematical abilities are not of quite the highest quality had the general proofs been more freely illustrated with specific examples.

There is an interesting paragraph on pages 25–26 dealing with the attempts (which do not appear to have been altogether successful) to represent orders of infinity by means of symbols. The writer is inclined to consider this subject, in its present condition, as being merely of the nature of a mathematical curiosity: we venture to suggest, however, that with further research it may prove to be of no little importance.

An appendix containing a bibliography of the subject, as well as another containing some numerical calculations (made by Mr. Jackson, scholar of Trinity College) bearing on the subject of the work, add to the value and interest of the book.

H. S. REDGROVE.

METEOROLOGY.

Hints to Meteorological Observers.—By W. MARRIOTT, F.R.Met.Soc. 75 pages. 25 illustrations. 9½-in. × 6-in.

(Edward Stanford. Price 1/6.)

We are glad to see that a seventh edition of this very useful little manual has been called for, and this fact is perhaps the best testimony to its worth. Mr. Marriott gives in clear and simple language just the information required by those interested in weather observation, and by following the instructions given anyone will be able to bring his local record into line with others and thus greatly increase its value.

The volume includes a set of Meteorological Tables, together with a particularly useful glossary of Meteorological terms.

MICROLOGY.

Animal Micrology.—By MICHAEL F. GUYER, PH.D. 240 pages. 71 illustrations. 6-in.×9-in.

(Cambridge University Press. Price 7/- net.)

Brief, practical and definite descriptions of the most important modern methods of microscopic technique have been prepared by Dr. Guyer and combined with a simple account of the microscope and a consideration of standard reägents, to form a useful book for those who are taking up microscopical research. Methods of preparing material and of examining particular kinds of creatures are also explained.

NATURE STUDY.

Nature's Pageant.—By MARGARET CAMERON, LL.A. 120 pages. Numerous illustrations. 6¼-in.×8¾-in.

(Blackie & Son. Price 1/-.)

This book, which is intended for very young children, carries out the nature study idea in so far as it deals with the seasons. It is, however, open to the objection that in it the animals are endowed with speech, and though fairy tales as fairy tales are interesting and stimulate imagination, much of the false sentiment of modern times is due to dealing with animals as if they had exactly our thoughts and feelings.

PSYCHOLOGY.

An Introduction to Experimental Psychology. By CHARLES S. MYERS, M.D., Sc.D. 156 pages. 20 illustrations. 6¾-in.×5-in.

(Cambridge University Press. Price 1s. net.)

On the scientific merit of Dr. Myers' little book the verdict of expert opinion will be favourable. The topics for treatment are well selected; the treatment itself is careful, lucid and effective. Those who are not experts will probably turn to this brief introduction to ascertain what are the claims of those who advocate the application of the methods of experiment in psychology, and how far there is some promise of these claims being made good. We fear their off-hand verdict may not be so favourable. They will turn, perhaps, to the chapter on memory, and they will find that the experimental work deals with the associative linking and subsequent revival of pairs or groups of nonsense syllables. They will wonder why such emphasis is laid on the nonsensical, and ask, perchance, whether *this*, then, is the new psychology. All suggestion of meaning seems to be regarded as a disturbing factor, which only ceases to give trouble "as the subject becomes more expert." They should remember, however, that what we glibly talk of as memory is a pretty complex business, and that the only chance of dealing scientifically with such a complex is to follow up in detail the several threads which are subtly interwoven. They should remember, too, that, in the course of experimental work, the mere fact of endeavouring resolutely to exclude meaning is a means to the realisation of how readily some significance is apt to be suggested. Dr. Myers might, perhaps, have insisted on the value of the experimental method in stimulating that introspection to which the novice in psychology is comparatively unaccustomed. The current perusal of such a book in a spare hour will not enable the reader to do justice to its merits, or to grasp how much real psychological value there is in experimental work.

C. LL. M.

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TOPOGRAPHY.

Burma: A Handbook of Practical, Commercial and Political Information.—By SIR GEORGE SCOTT, K.C.I.E. 520 pages. Numerous illustrations. 5¼-in. × 7½-in.

(Alexander Moring. Price 10/6 net.)

Sir George Scott's readable account of Burma is well known, and in noticing the second, new and revised edition, we may say that Natural History and Geology are considered in some detail, while the hints to visitors or new residents make the book more valuable.

Ruins of Mexico. Volume I.—By C. GEORGE RICHARDS. 153 pages. 262 illustrations. 13¾-in. × 9½-in.

(H. E. Shrimpton. Price 42/- net.)

During his wanderings amongst the ruins of Mexico, Mr. Constantine George Richards has collected a fine series of photographs, and to form the first volume of his book which is now before us, he has put together two hundred and sixty-two collotype reproductions of his pictures. In his introduction he says that there is nothing scientific, literary, or new in his work, but those who are privileged to see it will be ready to assure him of the value of his records of the ruins of the times before the Spanish Conquest.

QUERIES.

Readers are invited to send in Questions and to answer the Queries which are printed here.

46. BIBLE ASTRONOMY.—What would be the effect on our planet and other of this system if the sun and moon were to stand still as stated in the book of Joshua in the Bible?

J. W. A.

47. GRAVITY.—I heard it stated in a sermon, preached in a village church a few Sundays ago, that the reason we do not tumble off the earth is because it is surrounded by the atmosphere, which keeps us from flying off into space. No allusion whatever was made to gravity. Talking it over with a friend afterwards, she informed me that gravity was now rather discredited by scientific men, and that, if the atmosphere was not the sole cause of our remaining on the earth, at all events it had a good deal to do with it.

This is such a very novel theory to me that I venture to write and ask you if there is any truth in it?

IGNORAMUS.

48. THE COOLING OF HOT WATER.—There is a popular belief that boiling water freezes faster than cold: apparently it is also held that it cools more rapidly when the thermometer does not fall to 32° F., for I have heard of very hot water being put ready overnight for a bath in Jamaica in the belief that this would furnish the coolest morning tub. That the belief is false in most cases I have convinced myself by a "fool's experiment": on a night of hard frost I put out water at boiling point, water that had boiled for some time, and cool water, in similar vessels, with the result that might have been expected: the cold water was ice some hours before the others. But can you or any of your readers tell me what gives rise to such a singular and unexpected fallacy? Are there any conditions under which boiling water could freeze more rapidly than water at any lower temperature?

A. F.

NOTICES.

THE HOME OF GILBERT WHITE.—In *The Country Home* for July there is a thoroughly-well illustrated article on "The Wakes at Selborne," by Miss Amy Astbury. We believe that pictures of many of the rooms have never been published before, and we are able, by the courtesy of *The Country Home*, to print below, one of the rooms in which Gilbert White wrote "The Natural History of Selborne."

WHO'S WHO IN SCIENCE.—Messrs. J. & A. Churchill are preparing a new annual book of reference which will contain the names, appointments and achievements of the foremost scientific men in the world. Schedules are now being sent out and the coöperation of all those interested in science is invited. The forms should be returned, as soon as possible, to 7, Great Marlborough Street, London, W.

The room in which Gilbert White wrote "The Natural History of Selborne" and in which he afterwards died.

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